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Gas Journal

VOL. 293. 110th YEAR. LONDON, JANUARY 29, 1958 No. 4933 PRICE 1/6

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something in common

They remind one of different worlds, the Spanish forged iron pistol of 1850 and the modern T.G. meter. Yet, they have something in common—both are the products of true craftsmanship. The pistol delicately engraved and inlaid with damascene, designed and made by Eusebio Zuloago of Madrid, is presented as a fine example of the gunsmiths skill. The T.G. meter epitomizes craftsmanship and the T.G. 'G' prepayment mechanism is accepted as the most modern precision movement on the market. Something else is common, this Spanish pistol and a T.G. meter were both exhibited at the Great Exhibition of 1851.

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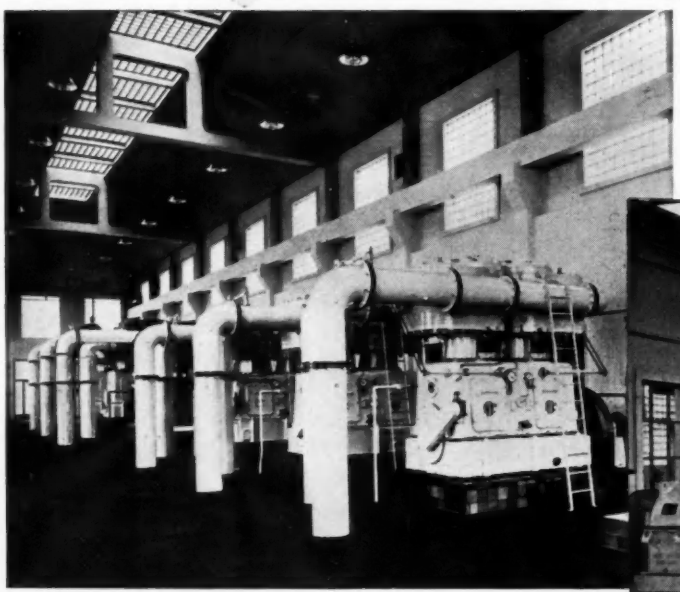

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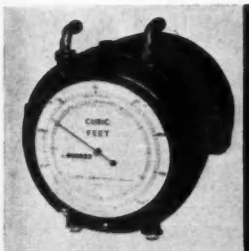

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Gas Journal

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110TH YEAR

MANAGING DIRECTOR: Clifford A. King

EDITOR: Geoffrey W. Battison

ASSISTANT EDITOR: Colin J. Godbold

TECHNICAL EDITOR: Charles J. P. de Winton, T.D., M.A., M.Inst. Gas E., M. Inst. F.

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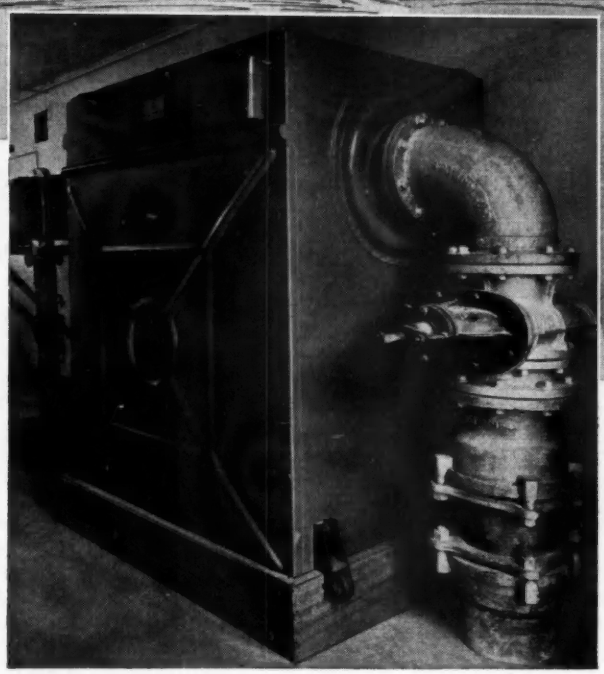
Britain's industries use gas extensively, and wherever gas is used there's a gas meter . . . and it's likely to be a Thomas Glover meter. T.G.'s have supplied meters for all types of industrial establishments. We are specialists in the manufacture of meters for special requirements, and pride ourselves on being able to supply any capacity required—size is no obstacle. Why not consult us about your industrial requirements? You'll get the meter you want and you'll get it on time. You'll be satisfied with the T.G. service and the finished article. The T.G. Industrial Meter is a "tailor made" product of true craftsmanship, renowned for its accuracy in measurement.



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1958

Gas Journal

VOLUME 293. No. 4933. JANUARY 29, 1958. 110th YEAR

Power from Atomic Fusion

THE successful outcome of any scientific experiment based on pure theoretical reasoning has something of special interest for the layman whether he really understands or not the implications of the experiment or the possible impact it might have on the lives of the general public in the course of years. This is particularly so where the production of fuel, power and energy is concerned. The available sources of fuels, both conventional or fossil and unconventional or those depending on nuclear fission, can be exhausted in the course of time. If we consider the upward tendency in the standards of life which is continually making itself felt by the increase in industrial production in already industrialised countries and the attempts to introduce industry into purely agricultural communities and the accompanying increase in energy demands, the exhaustion of these energy sources is likely to be all too soon. If sufficient energy resources are to be made available to maintain and increase not only the present standards of the world's population of today, but those of a rapidly increasing number in the future, some other source of energy will have to be found. Such a source must be readily available to countries like the United Kingdom having no natural gas, oil reserves or precious mineral deposits, and whose fossil fuels are being rapidly worked out.

It is for reasons such as these that the revelation of the taming of the hydrogen bomb for the production of power for industry instead of the destruction of mankind has fired the imagination of the general public.

To get the whole achievement into perspective and to make possible a reasoned and balanced assessment of its application to future power supplies, the world Press was invited to Harwell last week to inspect the latest experiments going on in the field of atomic fusion and to hear from Sir John Cockcroft himself, the Director of the Atomic Energy Research Establishment, what progress was being made towards its application to the production of energy on an industrial scale.

The apparatus in which the atomic reaction takes place is completely unconventional according to any standards hitherto visualised in industry. This is because the conditions under which it takes place were until lately unknown and do not even show any similarity with those in accepted atomic fission plants.

To make it possible for light atoms to fuse together to form a heavier atom, it is necessary first to ionise them completely and then to endow them with such an immense amount of energy that the natural repulsion between bodies charged with electricity of a similar pole will be overcome. To accomplish this, temperatures of over 1 mill. °C. are necessary in the gas. These temperatures can be obtained by electric discharges of great intensity in the gas; and by making use of the magnetic effect of an electric current to prevent the atoms coming in contact with the containing walls, the loss of heat from the gas and destruction of the container can be avoided. Such a phenomenon is known as a 'pinch effect' and ensures that the gas is concentrated at the centre of the tube. Since this magnetic effect becomes unstable during the discharge, the compacted mass of atoms in the centre of the tube tends to 'wriggle' towards the container walls. To counteract this a magnetic field of up to 400 gauss must be applied parallel to the axis of the tube. The tube in which the reaction takes place is ring shaped, similar to the inner tube of a tyre, known technically as a torus. This is made the single turn secondary winding of a large impulse transformer. Such a shape avoids the use of electrodes at the ends of the tube and the consequent loss of heat. Deuterium or heavy hydrogen flows through the torus at the very low pressure of about 1μ Hg (10^{-3} to 10^{-4} mm.) and after previous ionisation to deuterons by the loss of an electron is subjected to an electrical discharge of 20 kV

at 200,000 amps, or the equivalent quantity of 500,000 joules of power (14 units of electricity) for 1 millisecond, every ten seconds.

The torus, which is 1 m. bore and 3 m. in diameter, is made of aluminium 1 in. thick, but is provided with a window, through which the mauve flash of the discharge is seen. By means of a spectrograph it is possible by measuring the thickening of certain known lines in the spectrum to calculate the speed of the atoms, making use of the well-known Doppler effect. From this the temperature of the gas is arrived at. Since deuteron is an ion and not an atom, an impurity such as nitrogen or oxygen, which, since it is a heavier element, will not become completely ionised, is introduced to give a line in the spectrum. To ascertain whether indeed fusion is taking place, it is necessary to detect the presence of neutrons. This is accomplished by taking 'smear' photographs on 30 mm. film at microsecond exposures. It was in fact the detection of neutrons on August 30, 1957, which told the scientists that atomic fusion was indeed taking place.

The temperatures now being obtained are about 5 mill. °C., but the quantity of energy being produced is infinitesimal, which is why the apparatus has been named Zeta (zero energy thermonuclear assembly). To obtain any useful energy, it will be necessary to raise the temperature to 100 mill. °C. or above. To make use of this energy for power production, when it becomes available, it can either be used as heat and through the steam cycle converted to electricity or there are good grounds for supposing that means may be devised for a direct conversion to electricity without the losses inherent in the steam cycle.

Although the scientists know that they are on the right track, they also realise that a great deal of work must be done before such an atomic reaction is producing power and many years will elapse before an industrial plant begins to take shape. This process has so many advantages over those in present use. Perhaps its greatest are that the oceans will supply the raw material and since no radio-active elements are involved there are no dangerous effluents to be disposed of as in nuclear fission.

All-out Campaign by Parkinson

IT is always encouraging to learn of a gas appliance manufacturer embarking on an imaginative sales promotion campaign. Such a campaign has been planned by Parkinson Cowan Appliances, Ltd., for February (usually a dull period) when their Renown Six cooker is being heavily publicised through a variety of media. Originally it was intended to take time on all I.T.V. transmitters in the country and then seek the support of gas boards, but since it proved impossible to make adequate bookings from the London transmitter until the summer months, Parkinsons decided to concentrate on the transmitters in Birmingham, Manchester and Leeds. They will have 22 advertisements varying in time of 15 to 90 seconds and including two live commercials, nearly all at peak viewing times, beamed from those stations during the month. With the exception of the two live commercials the time taken is in the magazine programmes 'Lets Go Shopping,' 'What's in Store,' 'Its a Woman's World,' 'Homes and Gardens' and 'Mid-week Miscellany.' The Birmingham, Manchester and Leeds stations cover the Boards of the East Midlands, West Midlands, North Western and North Eastern, and there is an over-lap into parts of Wales and the South Western.

The campaign is being supported by extensive advertising in the local Press; by large posters which will appear on many of the various Boards' hoardings, and smaller ones for their windows and showrooms; by special showroom displays; and by leaflets and a booklet about the campaign for distribution in the areas covered by the transmitters.

In addition, Parkinsons have campaigns for the same period in the North Thames, Eastern, and Southern Boards, and in the Glasgow Division of the Scottish Board; except for television these will have similar backing. The whole is supported with large space advertising in the national Sunday and the London evening papers.

This is the first time that a cooker manufacturer has seriously explored the possibilities of large scale TV advertising and we wish Parkinsons all success. They are helping not only themselves but the whole industry.

Wanted! A T.V. Spokesman

THE last few months have not been happy ones for gas industry prestige. What with gas main explosions, coroners' courts, service complaints and quarrels with local authorities, life has been singularly difficult. Now we have to contend with the creation of television as an arch-inquisitor whose accusing gaze is apt to be turned upon our weak spots. We have already referred to the damage which can be caused by these embarrassing moments, and if the clatter of dropped bricks is not to be allowed to develop into a steady rumble, we must have an on-the-spot spokesman who can look after our interests. In other words, we need a *television personality* of our own who can tackle sticky technical questions and present gas in the best possible light. Nominees for the rôle? We suggest Messrs. H. R. Hart, J. D. C. Woodall, and R. N. Le Fevre.

Annual Report Film

ONE of the industrial relations problems which a gas board has had to face has arisen out of the difficulty of forming personal contacts between people living and working at widely separated points in the board's area. In some areas the pre-vesting parochial outlook has to some extent continued to persist and it has not been an easy task to induce in the minds of employees a feeling of belonging to a board team and not just an individual unit.

In the Northern Gas Board this problem has been of particular difficulty so far as the dissemination of information about the Board's achievements and the record of its activities year by year has been concerned. In an endeavour to meet this situation it has been the practice to hold each year, shortly after publication of the Annual Report, a meeting of employees which has come to be known as the 'Shareholders Meeting,' attended by representatives of joint consultative committees, etc. As only about 80 of the Board's 6,000 employees could be accommodated at the meeting, the aim did not wholly succeed.

The Board has therefore taken the unusual step of making a film to bring to employees a pictorial summary of the year's work. The film has been produced, in collaboration with the Board's staff, by Turner's Film Unit, Newcastle-upon-Tyne, and runs for 21 minutes. It is not primarily a production for public exhibition, but is essentially a family affair as its title indicates.

The film commences with a short statement from the Chairman of the Board, Mr. E. Crowther, and the remainder of the film consists of sequences linked together with a commentary spoken by the Chairman. In addition

to members of the Board and chief officers a considerable number of employees feature in the film and while the more serious subjects naturally take up most of the film, a certain amount of time is devoted to such lighter aspects as sports meetings and the like. The film closes with a short summary by the Chairman of the financial aspects of the year's work and with pictures of the Board taken in actual session.

Shows are now being arranged in divisions and units so that everyone has an opportunity of seeing the film and it is hoped that if the reception is favourable, such a report film will become an annual event.

The gas industry, a pioneer in the making of selling films, has, like many other industries, used film extensively for many purposes, including education, training and public relations, but so far as is known this is the first time that a film has been used to illustrate an annual report and to foster good industrial relations in this form.

Strength Through Contrast

AN expert on the subject has condemned many gas showrooms for being 'vaguely institutional' in appearance, but there are few showrooms of post-war origin at which this criticism can fairly be levelled. Certainly it does not apply to the new North Thames showroom in Upper Street, Islington, which was opened last week by Councillor Edwin Bayliss, Chairman of the Board's G.C.C. Here the architect, Mr. J. G. L. Poulson, of Pontefract, was faced with an interesting problem in that the site was in an extremely busy thoroughfare in which shopkeepers sought to gain the attention of passers-by by uninhibited use of neon lighting and facia panels of unparalleled gaudiness. How then to introduce a new message and a new appeal? Mr. Poulson, with a dozen gas showrooms to his credit in the north of England (including the exciting one at Morley and a soon-to-be-opened corker at Huddersfield), refused to use the weapons employed by his Upper Street competitors. Instead he favoured a clean-cut, modern design which showed considerable restraint. Flanked by buildings bearing neon tubes writhing like giant mechanical rambler roses, the gas showroom with its two office floors above scores with well-proportioned windows and contemporary curtain walling. Its sign 'North Thames Gas' is modest but compelling; its showroom window is angled to avoid reflection (in which it fails) and is set back to provide shelter; its interior decor makes use of ceramic tiling, wood panelling and terrazzo flooring in a restful yet contemporary fashion; and a Radiation 'Whole House' warming unit provides the heat. It is, in fact, a tasteful and effective piece of work and we hope the good burghers of Islington and Finsbury will give it the attention it deserves.

Personal Notes

MR. COLIN W. SMETTEM, Solicitor to the North Western Gas Board, is being seconded to the Board's Liverpool Group as Assistant to the General Manager, MR. J. G. O. DRAKE. The secondment, which will be for an initial period of 12 months, will begin on March 1. During it the Board's legal department will be administered by the Deputy Solicitor, MR. LESLIE CATTELL. Mr. Smettem has been with the Board since its formation in May, 1949. Previously he was Assistant Town Clerk at Wallasey. While there his duties included acting as solicitor to the Wallasey Ferries and the Gas and Water Committees. In January last year he was selected by the Board to attend a 3 months' course at the Administrative Staff College, Henley-on-Thames. Before going to Wallasey he served with the Scarborough Corporation. He was articled in 1933 to the Town Clerk and Clerk of the Peace at Scarborough. He qualified as a solicitor in 1938. Mr. Cattell was Assistant Solicitor to the Wallasey Corporation before joining the North Western Gas Board.

MR. S. THOMSON, Director and General Manager—Sales, of Ideal Boilers & Radiators Ltd., is retiring at the end of the month, and MR. F. L. SHAW, who has been with the Company for many years, has been appointed General Manager—Sales. Mr. S. Thomson is also relinquishing his position as Chairman of the Cast Iron Heating Boiler & Radiator Manufacturers' Association and his Directorship of the British Bath Manufacturers' Association, but will retain his seat on the Board of Ideal Boilers & Radiators Ltd.

MR. GEOFFREY DRAIN has been appointed Deputy General Secretary of NALGO—the National and Local Government Officers' Association—in succession to MR. W. C. ANDERSON, who recently succeeded MR. J. H. WARREN as the Association's General Secretary.

MR. A. J. BEANLAND has been appointed Group Sales Director of the Lancashire Dynamo Group. Mr. Beanland, who will be a Director of Lancashire Dynamo Group Sales, Ltd., will be in charge of the L.D. Group sales organisation at home and overseas.

CORRESPONDENCE

How Useful is the W.G.F.?

DEAR SIR,

You wondered 'How useful is the Women's Gas Federation.' As you point out, the Federation's prime concern is with home-making, but if one interprets its usefulness in terms only of its publicity and sales value to the industry, then the crux of the matter lies in your point that the value of the Women's Gas Federation depends entirely on the use made of it by the various boards.

The Harrogate branch of the Women's Gas Federation (then the Women's Gas Council) was formed long before vesting day, and at the request of the Manager of the Harrogate Gas Company, members gave their opinions of the various appliances from the points of view of the people who were using them, which led to improvements and modifications. Today, our activities still benefit the industry by developing interest in gas appliances and in the use of gas in the home.

In this branch, for example, one meeting per year is devoted to the exhibition and explanation of the latest appliances by the group sales manager. The meeting is always very well attended, and as a direct result of the last one, held in October, one 3528 range at £99 17s. 6d. and one Cadet cooker at £21 18s. 0d. were sold on the following day. I gather that similar meetings are held in Scarborough and York with similar results. An 'Appliance of the Month' is also on view at each meeting, which is demonstrated by the home service adviser.

Our programme for 1958 includes three meetings with a direct bearing on the work of the Board, the speakers being the Chief Accountant, the Chief Medical Officer, and the Group Sales Manager. Evidently the Board does not regard this as sheer waste of time. If more Boards were thus to invite co-operation, with a view to increasing knowledge, publicity and sales, then more branches of the Women's Gas Federation would perhaps be regarded as assets. The critics of the middle-aged tea drinkers might be wiser to take the opportunity while it still offers.

Yours faithfully,
MARJORIE ROBERTS (MRS.).

Bankfield,
6, Tewit Well Road,
Harrogate.
January 23, 1958.

GAS IN NORTHERN IRELAND

Gas Production Costs Leap at Rate of £60,000 a Year

DUE to the upward trend in prices, gas production costs in Belfast in 1957 increased at the rate of £60,000 a year. The Gas Department supplied more than 5,427 mill. cu.ft. of gas for domestic and industrial purposes during the year.

In common with other gas undertakings, the Department had to increase its prices earlier in the year, but the new charges are lower than in most comparable cities in the United Kingdom in spite of the much higher cost of coal locally.

During the year 231,001 tons of coal were carbonised, and in addition 1,800,547 gal. of gas oil were used for gas making purposes.

Supplies of coal were plentiful and the quality was reasonably good, but the cost of coal (over 5½ times the pre-war price) continued to be the Department's greatest handicap.

Demand for coke was well maintained, and there is every indication that sales will exceed the 74,037 tons that were sold during the last financial year, bringing in a revenue, when added to internal consumption, of £501,833.

Despite extremely competitive selling conditions a total revenue of £159,760 was obtained from the sale of by-products manufactured in the chemical section.

Reconstruction

Total revenue from all the activities of the Department for the financial year 1956-57 amounted to £2,886,244 and the total working cost amounted to £7,203 more than that figure.

A considerable amount of extension and reconstruction of the gas-making plant is being carried out and the first section of a vertical retort reconstruction, being executed at a cost of £400,000, was put to work a short time ago. When the second section is complete it will mark the end of a major programme of carbonising plant reconstruction that has been in progress since 1946, and it will leave the Department well equipped with modern plant that should be capable of meeting the requirements of the city for many years to come.

Bangor (Co. Down) Borough Council has made application to the Northern Ireland Ministry of Commerce for a loan of £100,000 for the reconstruction of a continuous vertical retort installation capable of carbonising 50 tons of coal per day.

Change of Address

The Nottingham area sales office of Lancashire Dynamo Group Sales, Ltd., is now 2, St. James's Terrace, Standard Hill, Nottingham (Telephone, Nottingham 43025/6).

COMPANY OPENS RESEARCH STATION

TO extend their activities in the chemical engineering and automatic control fields, Constructors John Brown Ltd., has recently established a research and development station at Leatherhead, Surrey.

The station will cover process development and investigation of chemical engineering problems, development of automatic control systems and their application, and special problems of nuclear engineering.

Merger Proposed

Negotiations aimed at combining the activities of the Yorkshire Copper Works Ltd. and Imperial Chemical Industries Ltd. in the copper and copper alloy tube and plate industry have now reached a stage when the Yorkshire Copper Works Ltd. is in a position to submit merger proposals to its shareholders.

OBAN TO INSTALL NEW COKE SCREENING PLANT

NEW coke screening plant soon to be installed at Oban gasworks will mean better quality coke for local consumers as well as effecting a considerable saving in costs for the Scottish Gas Board.

Improvement of gas quality in Oban over the past two years has meant the use of more coal and consequently the production of a greater supply of coke. Demand for unscreened coke has never been particularly high, and it was found impossible to sell the increased total output locally.

MEMORABLE YEAR FOR BRADFORD

AT the recent annual meeting of the Bradford branch of the Women's Gas Federation, Mrs. G. L. Garbutt, President, said that the past year, which was also the 21st of the branch, had been memorable. Twelve new members had been admitted and all the meetings had proved extremely profitable.

Miss G. D. Exley, Treasurer, reported a credit balance of £44. Speakers included the Chairman, Mrs. M. E. Saville, and the Secretary, Mrs. H. Hopper. Mrs. F. Watmough was elected to the committee.

Diary of Forthcoming Events

January 31.—JUNIOR INSTITUTION OF ENGINEERS: 'The Clean Air Act and the Engineer,' E. C. Rogers. Pepys House, 14, Rochester Row, Westminster. 7 p.m.

January 31.—INSTITUTION OF CHEMICAL ENGINEERS, Graduates and Students Section: Caxton Hall, London, S.W.1. 'Instrumentation in the Chemical Industry,' P. W. Mason, 6.30 p.m.

February 4.—SOUTH EASTERN G.C.C.: Caxton Hall, London, S.W.1, 11 a.m.

February 4.—INSTITUTION OF CHEMICAL ENGINEERS: Burlington House, London, W.1: Three papers, including 'Mass Transfer Between Fluidised Particles and a Gas,' by J. F. Richardson and A. G. Bakhtiar. 5.30 p.m.

February 4.—MIDLAND JUNIORS: West Midlands Gas Board, Council House, Birmingham: Paper, 'Some Notes on Gas Governing,' by H. E. Shaw and M. W. Jeavons.

February 4.—COMBUSTION ENGINEERING ASSOCIATION (NORTH-WESTERN REGION): Brains Trust on 'Mechanical Handling, Storage, and Conditioning of Solid Fuel,' and 'Automatic Regulation of Combustion Conditions—Small and Medium-Size Boilers.' E. Burman, Teddington Industrial Equipment, Ltd.

February 5.—JUNIOR INSTITUTION OF ENGINEERS (MIDLAND SECTION): James Watt Memorial Institute, Birmingham. 'Available Energy,' by R. D. Gifford. 7 p.m.

February 5. — INCORPORATED PLANT ENGINEERS: Bell Hotel, Leicester. 'Trade Waste Effluents,' by S. J. Roberts. 7 p.m.

February 6. — ROYAL INSTITUTE OF CHEMISTRY (LEEDS AREA SECTION) AND SOCIETY OF CHEMICAL INDUSTRY: Queen's Hotel, Leeds. Open Meeting. 'The Petroleum Chemist's Contribution to Home Life,' by R. C. Tarring, of the Shell Chemical Co. 7.30 p.m.

February 7.—INSTITUTE OF FUEL (S. WALES SECTION): Park Place, Cardiff. 'Some Aspects of Fuel Efficiency in Modern Blast Furnace Practice,' by K. C. Sharp. 6 p.m.

February 8. — EAST OF SCOTLAND JUNIORS: Social Club Rooms, Edinburgh. Paper by R. J. Faulkner, Education and Training Officer to the Scottish Gas Board.

N.E.G.B. to Open New Showroom Next Month

THE new showrooms and offices of the North Eastern Gas Board at Shipley, Yorkshire, the only building of its kind in the area, is to be officially opened by the Chairman of Shipley Council, Councillor S. Radway, in about five weeks' time, when the whole building will be ready for occupation.

Part of the building was taken over for business during the second week in January. A feature of this very modern and up-to-date building is the glass walls which extend right up to the ceiling. The ground floor comprises the accounts department and showrooms.

The floor is made of Canadian maple, and the decorations are very bright—the ground floor ceiling is Indian cherry and the wallpapers on two walls are black and white with bold mosaic pattern on one and ornamental statues on the other. The staircase and shop fittings are mahogany.

The Eastern Junior Gas Association visited the Stanton Ironworks Co., Ltd., recently, and were shown the Dale Spun Iron Pipe plant and the Erewash foundry. They are pictured here in the Company's cinema after seeing a film dealing with the manufacture of pig iron and refined iron. They were later welcomed at a luncheon by Mr. G. R. Buckley, Assistant Managing Director (Works). The President of the Association, Mr. J. L. Ireland (centre of front row), thanked the Company and introduced Mr. Bernard Clarke (third from left front row), Divsional General Manager, Lincolnshire Division. Also in the front row are Mr. W. J. Pritchard, Senior Vice-President, Eastern Junior Gas Association (third from right), and Mr. J. W. Wilson, Divisional Distribution Engineer, Lincolnshire Division (second from right).

COMPANY PASSES FINAL DIVIDEND

THE Gas Purification and Chemical Company is not declaring a final dividend for the 15 months to June 30, 1957. An interim of 1s. per 5s. share was paid at end-March last. For the year to March 31, 1956, an interim of 75% on £94,132 preceded a 400% scrip issue. A final of 25% was paid on the increased capital of £512,912.

The present capital, as expanded by acquisitions, is £679,787. Group profits were £484,217, but after charging normal taxation of £126,676, and taking up subsidiaries' losses of £508,353, a deficit of £150,812 resulted.

Cut Taxes, says Engineers' Guild

A REDUCTION in the taxation of professional men and women in the middle and upper income groups to prevent a further decline in their standard of living is described as essential by the Engineers' Guild, representing engineers in all branches of the profession.

In response to an invitation from the Royal Commission on Doctors' and Dentists' Remuneration, a memorandum about the problems and prospects of professional engineers has been submitted and is published in the current issue of the *Journal of the Engineers' Guild*.

Holding Acquired

West's Gas Improvement Co. Ltd. have acquired a majority holding of the Ordinary shares of Tully Engineering Co., Ltd., Newark.

N.E.G.B. Fined for Selling Coke Under Stated Weight

THE North Eastern Gas Board has been fined £5 by the Halifax West Riding Court for selling coke under the weight stated and £2 for failing to cause the tare weight to be marked on the lorry taking the coke to a school. The Board pleaded guilty to both charges.

Mr. J. Wilson, prosecuting, said the load was found to be 105 lb. less than was stated on the delivery-note. Reference was made to the 'chaotic state of local law' in Yorkshire with regard to the marking of tare weights on vehicles.

Mr. S. L. Brunt, for the North Eastern Gas Board, said that in the West Riding some local authorities insisted on the tare weight being marked on the left hand side of the vehicle, and others on the right hand side, while some did not mind which side it was on.

Petition Lodged

Eston, North Yorkshire, Urban Council has received a petition from local residents against the proposed erection of a coke-oven plant at South Bank-on-Tees for the South Durham Steel and Iron Co. Ltd. The Council has deferred consideration of the petition for two months, and the matter will be discussed with the county planning authorities.

S.W.G.C.C. MEETS IN TAUNTON

THE South Western Gas Consultative Council met in Taunton last month with Sir Colin Campbell, O.B.E., in the Chair. Sir Colin expressed the pleasure of the Council at the presence of the Deputy Chairman, Councillor Mrs. B. J. Shell, who was recovering from a serious operation.

New appointments to the Council reported included Councillor A. E. Farrell, of Ottery St. Mary; Councillor T. Jones, of Bath; Councillor Mrs. N. Redgrave, of Frome; Councillor Major A. S. Phelips, of Seaton; and Mr. W. M. Barber.

H. & G. TO ERECT NEW GAS PLANT

A NEW carburetted water gas plant, with a capacity of 3 mill. cu.ft. per day, is to be built for the West Midlands Gas Board at Etruria gasworks, Stoke-on-Trent, by Humphreys & Glasgow, Ltd., of London. The contract has been signed, and work is beginning at once.

The new plant will help the Board to meet the increased demand for gas in Stoke, where there has been a striking change from solid fuel to town gas, particularly within the pottery industry. There are now some 330 gas-fired kilns in use in Stoke-on-Trent, and 112 factories use gas for their firing purposes.

Engineers' Wages Up

The 250,000 operatives employed in the civil engineering contracting industry are to receive a wage increase of 1d. per hour from February 3.

GAS USED IN CONTINUOUS PRODUCTION OF GLAZE FRITS

Stoke-on-Trent Firm Develops Special Plant

A GAS-FIRED continuous frit melting plant has been installed at the works of W. Podmore and Sons Ltd., Caledonian Mills, Stoke-on-Trent, for the production of high quality ceramic frits for glazes. It was developed and built entirely within the Podmore organisation with assistance from the industrial gas department of the West Midlands Gas Board at Stoke-on-Trent in the design of the burner equipment.

The incorporation of automatic drying of the product, which is then weighed and bagged ready for despatch, makes the process continuous from the charging of the basic material into the furnace to the final packaging of the finished product.

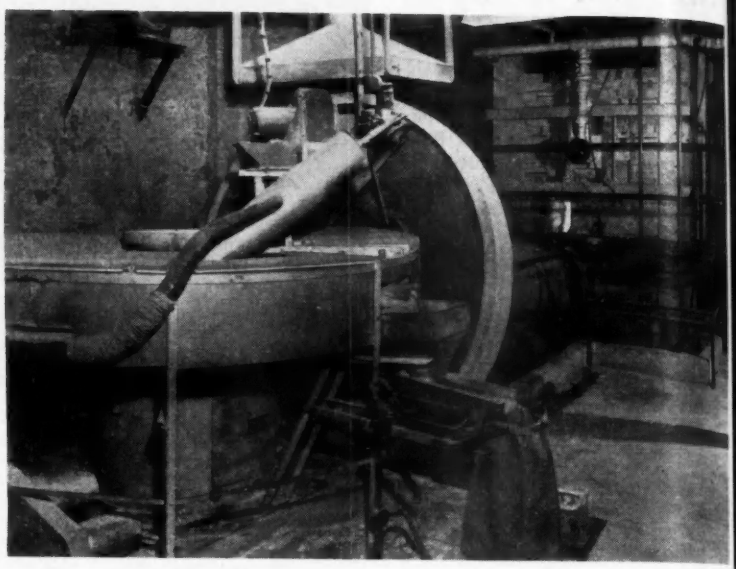
Glazes for application to pottery consist of finely ground lead and borax glasses which are known to the trade as 'frits.' When the glaze is applied to a clay body and fired to the appropriate temperature, usually between 1,050° and 1,100°C., the constituent frits melt, adhere to the surface of the clay and form that much desired smooth, brilliant, protective cover.

Lengthy Heating Required

These frits are made by heating to approximately 1,100-1,400°C. a mixture of pure minerals containing silica and alumina together with fusible compounds, such as litharge, borax and alkali carbonates, according to the particular type of frit required. The heating must be carried out for a sufficient length of time to ensure a homogeneous product free from gaseous bubbles which may have been liberated during the process.

Furnaces in general use for the manufacture of frit are either reverberatory hearth furnaces or rotary furnaces, and both these types operate intermittently as batch processes, requiring a heating period of about four hours at the appropriate temperature, after which the molten mass is run off and quenched.

In recent years a continuous type of furnace has been developed which is considerably longer than the normal reverberatory hearth furnace and has a sloping hearth at a carefully calculated angle. The mixture for fritting is fed in continuously at the higher end of the furnace where it melts, and the molten frit flows in a shallow stream down the hearth of the furnace to the lower end where it is discharged continuously, quenched and granulated by a high velocity stream of water.



The discharge end of the continuous frit melting plant.

The gas equipment on the furnace comprises a main burner of an air/gas proportioning type, rated at 2,100 cu.ft. per hour, firing from the front of the furnace so that the products of combustion pass in a contraflow direction to the molten frit. In addition there are two secondary burners, also of the air/gas proportioning type, situated at the higher end of the furnace, used to assist primary melting.

After being granulated the frit is automatically de-watered and dried on a rotary turn-table which incorporates a West Midland's type air heating unit, rated at 300 cu.ft. of gas per hour, for supplying high velocity hot air to the drying turn-table. The frit is then automatically discharged into bags and weighed ready for despatch.

When lead bisilicate frits are produced in a rotary type furnace, they may contain as much as 1.2% of refractory brick from the lining, while in the reverberatory type furnaces the proportion may be even higher, particularly if the furnace lining is nearing the end of its life. This new continuous furnace on the other hand gives a finished product containing less than 0.08% of firebrick.

The replacement cost of the lining of the furnace is, therefore, extremely low because of the longer life of the refractories and allows a more expensive brick with a negligible iron content to be used.

Lead bisilicate frits are generally amber in colour caused by the inclusion of iron and other impurities from the refractories during the melting process, but frits produced by the continuous stream process are of a very high and uniform quality. In fact, they can be white and fully transparent.

In the production of lead frit it is the general practice to use red lead as a constituent of the frit mixture, but in this new continuous plant pig lead is used. The metal is melted with gas burner equipment, reduced to a fine powder by atomisation, and then oxidised by waste heat from the frit kiln.

This method of producing the required lead oxide accounts in part for the exceptional efficiency of this continuous process. During the development of the furnace and of the technique employed for producing the frit, many types of fuel were experimented with and finally town gas was chosen as the most suitable fuel for the process.

Cheaper fuels, such as oil, are of course, available, but the impurities contained in these cheaper fuels were found to impair the quality of the glaze frits and caused, in particular, difficulties in colour matching. Other important factors in favour of town gas were its ease of control, deemed a necessary attribute to the new technique of continuous production, and that its products of combustion formed a most desirable furnace atmosphere.

Standard Output

In this plant waste heat products from the melting furnace are used for preheating the frit mixture, for the oxidation of the finely divided metallic lead and finally for preheating combustion air. The final temperature of the flue gas products entering the stack after preheating the air for combustion is approximately 100°C. For a standard type lead bisilicate frit the output of one of these furnaces can be as high as 20 tons per day, with a gas consumption per ton of lead bisilicate frit, including melting and oxidation of the lead, fritting and drying, of about 30 therms of town gas.

Comparable figures for a coal-fired intermittent reverberatory furnace are about 250 therms per ton, and for a gas-fired reverberatory intermittent furnace approximately 75 therms per ton.

From a paper to the London and Southern Junior Gas Association, December 3.

The Case for Organic Sulphur Removal

By F. BROOMHEAD, B.Sc., Assoc.M.Inst.Gas E.,
LONDON MANAGER, W. C. HOLMES & CO. LTD.

MOST of us will claim agreement with the aim of low-sulphur gas. But how often have we heard that an organic sulphur removal plant is a luxury that cannot be justified, particularly when capital expenditure is curtailed; that it is unnecessary when only a small proportion of consumers really need low-sulphur gas for processes, which demand can be satisfied by removal plant at consumers' factories at their expense; and that the price of gas is already too high for the industry to afford this additional production cost.

Organic sulphur removal must obviously involve a production cost, and this must inevitably increase the 'cost of gas into holder,' so it is readily understandable that the production engineer will not view the proposal with any enthusiasm. On the other hand, the magnitude of the additional production cost we have under consideration is less—for a limited sulphur removal appreciably less than 1d. per therm. Furthermore, let us note certain aspects of the situation on the credit side.

There is no problem of sulphur dioxide in flue gases for the consumer who chooses electricity, butane, propane or paraffin, as his fuel. One is tempted to question if the gas industry really justifies its claim to supply the public with a refined fuel, and even if it can afford *not* to purify its product more effectively than at present, if it is to continue to compete successfully with these alternative fuels.

The gas industry's mainstay is the domestic market, and here, above all, the challenge must be met. In common with most domestic consumers I consider my own heating requirement from the aspects of cost and comfort. In order to avoid respiratory discomfort from sulphur dioxide I am obliged to fit a flue on my water heater and fire, knowing full well that in doing so I am throwing away over 50% of the space-heating value of the gas for which I am paying 1s. 11d. per therm.

My refrigerator and cooker are not fitted with flues, so that I am constantly aware of the sulphur content of the gas supply, particularly if doors are kept closed and the flue gases are discharging into a confined space. In such cases, I am exasperated by the thought that I am suffering only because of my loyalty to gas. I am sorely tempted to revolt when I see the dreadful state of the burners and surroundings on the refrigerator and the water heater, and I feel anything but cheerful when paying the account to the gas board for maintenance services rendered to appliances made unserviceable by the fuel it supplies.

Background Heating

Space heating, particularly background heating, could be an expanding market for the gas industry. The average consumer would, I think, choose a paraffin heater for this duty. It has certain disadvantages, it is true, mainly associated with fire risks, but the effective therm would cost him only 1s. 6d. With gas at 1s. 11d. per therm, in a flueless appliance, one might prefer it in order to eliminate the potential dangers of the oil-fired appliance, but few consumers would be willing to pay perhaps 4s. 3d. per effective therm, which the flued appliance would cost to operate, for that extra safety. On this basis, and quoting from my own circumstances, electric heating at 3s. 8d. per therm would be a more economical proposition.

We must, therefore, recognise that gas is too expensive a fuel to justify the use of appliances at only 45% efficiency, if we are to extend or even retain our share of the domestic market. The use of flueless appliances can, however, prosper only if a drastic reduction of the present level of organic sulphur content is achieved. The oil industry has been very active in eliminating public resistance to the domestic use of paraffin. It has gone a long way, at some expense, to provide a delivery service to the home, which falls only just short of piped supply. Indeed, one can almost visualise that the oil industry of the future might even lay down a piped distribution system, if it believed its interests would be furthered by so doing.

The gas industry's main prospect for expansion is in the industrial field, where its principal competitor recently has been oil. Undoubtedly the success of oil for heating purposes has been due to a favourable price, but as the cheaper fractions usually contain sulphur, it is possible that some of this business could be attracted back to gas if it were purified of its sulphur content. This would eliminate the need for muffle type furnaces, increase the operating efficiency, and at the same time cheapen the effective therm.

A more serious competitor has now appeared on the industrial scene, namely, liquefied petroleum gas. This possesses most of the attributes normally claimed by the gas industry for its own product and at the same time is sulphur-free. Butane can be purchased in bulk at about £21 per ton ex-refinery and be delivered to a factory 100 miles away at little more than 1s. per therm. Storage and vapourising equipment at the factory might not add more than 1d. per therm, depending upon the size of the installation, to cover capital charges and running cost. Here, therefore, is a supply of high calorific value, sulphur-free gas costing no more than town gas, and available to all industry almost irrespective of its geographical position in relation to centres of gas manufacture.

Pipe Size Unimportant

The gas industry should note, too, that with a supply of liquefied petroleum gas there is unlikely to be any difficulty from lack of pressure even when increased load is contemplated. Pipe size is relatively unimportant, owing to the ease with which the pressure of the gas in storage can be raised by the application of heat, and also because the calorific value is so much higher than that of coal gas. The industrialist planning an expansion of heating load is not therefore faced with a considerable expenditure in laying a new main of larger capacity from the gas board's supply.

The use of L.P. gas is undoubtedly very attractive to the industrialist who is dissatisfied, for any reason, with his town gas supply. An example of this is the heat treatment of metals in controlled furnace atmospheres. In carburising, for instance, this has been achieved for many years by the catalytic adjustment of the composition of coal gas or the products of its partial combustion. A sulphur content of the coal gas in excess of about 7 grains per 100 cu.ft. is detrimental, and a number of catalytic organic sulphur removal plants have been installed in the past for such applications. The industrial demand for this type of equipment has now virtually ceased, as industry has discovered that butane and propane will provide the sulphur-free atmosphere its process requires.

It will perhaps be appropriate to review, at this stage, the steps which have been taken towards organic sulphur removal as a general policy of the gas industry. In 1942-43 a Committee of Enquiry of the Institution of Gas Engineers was set up to report on the subject. The Committee's report included the following conclusions and recommendations:

'Owing to the effects of the products of combustion of sulphur compounds in town gas, the cost of maintenance of apparatus is increased, the use of town gas for space heating is limited, and the prestige of the industry is prejudicially influenced. The sulphur content of town gas can be reduced to about 10 grains per 100 cu.ft. by processes which have been proved by experience. . . .A combination of the catalytic process with one of the processes for benzole recovery will be necessary in most circumstances if a lower limit of 3 grains per 100 cu.ft. is to be secured. . . . Any process installed to attain an imme-

diate reduction to 10 grains per 100 cu.ft. will form a part of the combination of processes ultimately necessary for a reduction to 3 grains per 100 cu.ft.

'The Committee therefore recommends that:—

(1) As a first step the organic sulphur compounds in all supplies of town gas should be reduced to 10 grains per 100 cu.ft. before the gas is distributed to the public and that immediate steps should be taken by all gas undertakings as soon as circumstances permit, to achieve this result.

(2) In view of the advantages which accrue when the sulphur content is reduced to 3 grains per 100 cu.ft., gas undertakings should be encouraged to make better use of the facilities available to enable them to attain this lower limit.

(3) The possibility of the attainment of a still lower limit of sulphur content should be kept continually under review and processes designed to ensure this should be examined as they become known. Should a practical process be developed steps should be taken to bring it to the notice of all gas undertakings.

(4) The possibility of obtaining a lower limit than 10 grains of sulphur per 100 cu.ft. should not be allowed to cause delay in giving effect to recommendation (1) above.'

Let us consider the Committee's various recommendations to assess how far these have been implemented, the processes available to achieve them, results obtained and the up-to-date costs of operation.

The first recommendation was that the sulphur content of distributed gas should be reduced to 10 grains per 100 cu.ft. Doubtless this limit was selected as that to be expected from the intensive oil-washing process, designed to achieve approximately 90% removal of carbon disulphide, and at the same time an even higher proportion of thiophen. Details of the design and operation of such plant have been published and a number of them were installed, curiously enough mostly between 1937 and 1942. Installations since 1942 have been on a limited scale only, due possibly to the fact that the incidental benzole recovery became progressively less profitable.

A total plant capacity of approximately 125 mill. cu.ft. of gas per day has been installed during the last 20 years, approximately half being designed for 50% CS_2 removal only. It would be interesting to learn how much of this equipment is actually in operation today, and especially how much is operating at maximum capacity.

It is perhaps unfortunate that this type of plant is so easily by-passed at times of peak load or calorific value stress, or shut down completely if benzole recovery becomes unprofitable or if coke stocks become too large. The effect on the district demands more serious consideration in future, since one has to remember that valuable industrial products, steel or glassware for instance, might easily be ruined by a lapse of this kind, even if it is only of a few hours' duration.

Limit of Achievement

There is one sulphur-bearing constituent in manufactured gas, namely, carbon oxysulphide, which is not readily soluble in gas oil. The concentration of this constituent, therefore, sets the limit of achievement of the oil-washing process to organic sulphur removal. In coal gas, carbon oxysulphide usually ranges from 6 to 10 grains per 100 cu.ft., although there are many instances of higher concentrations. Since there is a tendency for carbonising coal of higher sulphur content to produce gas with a greater proportion of carbon oxysulphide, it is becoming more difficult for the oil-washing process to remove sufficient overall sulphur to meet the 1942 Committee's recommendation.

Because of the progressively smaller proportion of distributed gas originating from the carbonisation of coal, it becomes necessary to examine the organic sulphur constituents of gas manufactured from oil. Here their concentration varies considerably with the type of process and the sulphur content of the oil. With certain feedstocks the gas is virtually sulphur-free and would need no sulphur removal treatment, but other feedstocks will produce gas containing organic sulphur in excess of 10 grains per 100 cu.ft. Since these catalytic oil-gas processes have been developed to utilise any readily available oil fraction, the imposition of a limit on sulphur content may be, to say the least, inconvenient.

The organic sulphur content of carburetted water gas, blue water gas and producer gas is principally in the form of carbon oxysulphide, and therefore not amenable to treatment by oil washing. It is sometimes present even in these gases in excess of 10 grains per 100 cu.ft., and should not be ignored if the Committee's recommendation is to be met. No doubt the sulphur in these gases originates from the coke used in the process, and any tendency for an increase there may be reflected in an increased organic sulphur content in the gas.

Finally the application of the oil-washing process to gas made from oil for sulphur removal, would necessitate an incidental recovery of benzole, which may introduce an Excise duty problem which undertakings would prefer to avoid.

The total operational cost of a plant based on the intensive oil-washing of 10 mill. cu.ft. of gas per day, would be in the order of .35d. per therm. A similar performance will be obtainable by the active carbon adsorption process, but the overall operational cost may be somewhat higher than that for the oil-washing process.

'Fronts Fraction'

Both these processes involve over 90% incidental benzole recovery, and consequently a calorific value reduction of the order of 30-35 B.Th.U. per cu.ft., which must involve the initial production of a correspondingly richer gas before treatment. To minimise the extent of the change in gas-making conditions, it is possible to return any proportion of the recovered benzole to the gas after removing from it a 'fronts fraction.' This is produced by a careful fractionation, so that almost all the carbon disulphide is concentrated into it. The weakness of this system, from the overall sulphur removal aspect, is that the thiophen is returned to the gas with the defronted benzole, as the two cannot readily be separated by distillation. The operation of this system, therefore, would be unlikely to achieve more than 50% overall organic sulphur removal.

A variation of this scheme which would appear to be a logical development and at first sight attractive, would be to replace the benzole therms by butane, which, in bulk for a 10 mill. cu.ft. of gas per day capacity works, could be purchased, stored and vapourised for perhaps 13.5d. per therm. Again, however, a legal point involving the payment of Excise duty may be introduced.

Let us now consider the second recommendation of the 1942 Committee, which stresses the advantages to be gained from a reduction of sulphur content to 3 grains per 100 cu.ft. It is unlikely that this figure could be achieved by any one single process unless the gas has been produced from an abnormally low-sulphur raw material. Doubtless the Committee had in mind a combination of the catalytic and oil-washing processes, but first we will consider the catalytic system only.

Since thiophen resists attack by catalytic methods, its concentration in manufactured gas will set the limit to overall sulphur removal by this process, but its concentration is usually lower than that of carbon oxysulphide. The sulphur content, therefore, can be reduced further by catalysis than would be possible with either oil-washing or active carbon. In fact catalytic treatment might yield a gas of around 5 grains of sulphur per 100 cu.ft., the major proportion of which will be thiophen.

The main disadvantage of the catalytic process lies in the fact that the conversion of organic sulphur involves the production of H_2S, which in turn must be removed before the gas can be distributed. Process economics are very dependent upon the cost of removal of this impurity, which might be achieved in various ways.

The first and obvious method would comprise a system of catch-boxes to follow the composite sulphur removal plant, which would be smaller than conventional boxes owing to the modest H_2S loading. In addition to a comparatively heavy capital expenditure, a special operating technique would have to be developed, because of the low heat of reaction. Running costs, due to frequent handling of charges of oxide with little spent oxide revenue on the credit side, may be high. Capital costs might be reduced by second-hand purifiers being made available from some redundant works in the area, but the dismantling, transfer, reconditioning and rebuilding of plant of this nature rarely proves an attractive economic proposition.

Another scheme of after-purification would connect the C.S.R. plant into the existing purification system, preferably comprising six boxes or towers. The gas connections could be arranged so that the C.S.R. plant becomes a seventh rotatable unit within the system and permanently located

between the third and fourth takers. In this way the gas entering the C.S.R. plant would always be relatively low in H_2S, if possible below 10 but certainly below 30 grains per 100 cu.ft. The gas entering the fourth taker, however, would carry an additional 20 or so grains per 100 cu.ft. and it could be expected that the fourth, fifth and sixth takers would be adequate to clean up the gas to the required standard.

The capital charges on these additional gas connections for, say, a 10 mill. cu.ft. per day capacity plant, would be of the order of .03d. per therm, and would not be an unattractive proposition. No special purification technique would appear to be necessary, except that since the gas leaving the C.S.R. plant will be virtually oxygen-free, additional air for revivification must be added at the inlet of the fourth taker.

An alternative after-purification system would utilise the 'Manchester' liquid process, incorporating two or possibly three washers, depending upon the amount of H_2S to be removed. This composite system commends itself in cases where there are only four existing boxes, and where to arrange the C.S.R. plant as a fifth rotatable unit would ensure neither low H_2S gas entering it, nor would the system necessarily provide sufficient margin to ensure final purification to the required standard.

The capital and running costs of the necessary liquid purification plant, on a basis of 10 mill. cu.ft. of gas per day capacity, would amount to .19d. per therm.

Capital and Running Costs

Considering now the C.S.R. plant itself; the units involved would be a booster, heat exchangers, a final gas heater, a catalyst vessel, a final cooler for treated gas, and catalyst regenerating and handling equipment. The capital and running costs for the plant of standard capacity would total approximately .41d. per therm.

The third recommendation of the 1942 Committee referred to the possibility of organic sulphur removal to a level even lower than 3 grains per 100 cu.ft. It has been indicated already that the thiophen content of the gas sets the limit to the performance of the catalytic process, but it will be remembered that thiophen is removed readily in the oil-washing and active carbon processes.

Clearly, therefore, if the two are combined, there is every prospect of achieving a final organic sulphur content of about 2 grains per 100 cu.ft. or possibly less. Since the solubility of thiophen in oil is very similar to that of benzene, a plant designed for high-efficiency benzole recovery may be used. This plant would be smaller and cheaper than that considered previously for the first recommendation, since it would operate at only one-third of the oil circulation rate, and by arranging it to follow the C.S.R. plant a low-sulphur benzole would be recovered commanding the best possible price. The capital and running costs of such a plant should not exceed .12d. per therm.

When planning a new works or even the extension of the purification system in an existing works the need to distribute gas virtually free from all forms of sulphur should be taken into account. Sulphur removal, inorganic and organic, should be regarded as one composite process, so that the following considerations are worthy of further thought.

The oxide purification process suffers from the fact that it must satisfy two requirements; namely it must purify the gas to the Gas Referees' standard, and at the same time it must produce a spent oxide containing at least 50% of sulphur on the dry basis, to be saleable. If either of these requirements could be relaxed, the other would be the more readily achieved, or alternatively the plant could be re-rated for a higher gas throughput.

Sulphur at an Economic Price

The system referred to removes from the main purifiers the necessity to purify the gas to the present legal standard, and in fact, permits it to discharge gas containing up to 30 grains of H_2S per 100 cu.ft.

A problem not yet resolved in the 'Manchester' liquid purification process, is the production of a marketable sulphur commanding an economic price. Although this is the subject of continuing research, it renders the process uneconomic by comparison with oxide purification at the present time. However, if liquid purification is applied to a system where the sulphur to be removed is extremely small, problems associated with the marketing of that sulphur virtually cease to exist. The process's proved ability to purify gas to well below the legal standard then renders it very suitable for the duty outlined above. Its use, too, would render unnecessary any final gas cooler on the C.R.S. plant, and as revivification of the circulating liquor is an external process, no air would be introduced into the gas stream. This reduction of 'inerts' coupled with the rise in calorific value resulting from the H_2/O_2 reaction in the C.S.R. plant, must be reflected in retort-house performance and an increase in therms per ton.

This composite sulphur-removal system should make possible a gas containing not more than 5 grains per 100 cu.ft., but if manufacturing conditions should produce gas with an abnormally high concentration of thiophen, it could be supplemented by a benzole recovery plant. This would yield a gas with a sulphur content of the order of 2 grains per 100 cu.ft., at an overall cost, including capital and running charges, of .72d. per therm.

New Gas Service Pipes Code

THE British Standards Institution announces the publication of a revision of the Code of Practice for Gas Service Pipes—CP. 331.101. First published in 1947, the Code was originally prepared by a committee convened by the Institution of Gas Engineers; and the same committee has handled this revision, which takes into account developments since 1947 in the technique of installing gas service pipes, and in the materials available for the purpose.

The Code deals with the service pipe from the gas supply main to the control, which is normally at the consumer's meter. It also deals with the provision, where necessary, of service valves and service governors. Emphasis is placed upon exchange of information, between those concerned in planning and execution, during the early stages of new building projects (the gas undertaking's role is particularly important—the undertaking is able to advise in connection with the position of the gas meter, the size of service, and the route of the service from the main to meter position).

The Code gives advice on the inter-relation of gas service pipes with other public services (water, electricity, telephone, etc.). Other advice concerns the desirable size of pipe bearing in mind its potential load. There are recommendations on the installation of service governors and on precautions which are appropriate when using governors which operate on a supply at a pressure in excess of ¼ lb. per sq. in. The Code contains reference to protection against corrosion and to matters which require attention when laying, testing and inspecting gas service pipes.

Copies may be obtained from the British Standards Institution, Sales Branch, 2, Park Street, W.1. Price 4s. 6d.

No Limitations on Appearance

THE first (1946) edition of B.S. 1308—British Standard for Concrete Street Lighting Columns—dealt solely with requirements for reinforced concrete street lighting columns. In the 1957 revised edition the scope of the standard has been extended to include columns of pre-stressed concrete, specification details for which were drawn up in the light of the results of a series of tests whose principal object was to ensure that columns of this material offered adequate resistance to impact. The standard is predominantly one of *quality* and *performance*.

Requirements are specified for three classes of column with a range of heights of 30 ft., 25 ft., and 15 ft. to 13 ft. The design of the columns is left to the discretion of the manufacturer, subject only to compliance with the requirements for concrete, reinforcement, cover, finish, spigots, nipples, ladder arms and service connections, and with the tests. The latter include type tests and proof tests for strength and water absorption.

Copies of this British Standard may be obtained from the Sales Branch of the British Standards Institution, 2, Park Street, London, W.1. Price 5s.

From a paper to the East of Scotland Junior Gas Association, November 9.

The Preparation of Water for Boiler Feed Purposes

By JOHN H. A. RAMAGE, B.Sc.,
EDINBURGH AND SOUTH EASTERN DIVISION OF THE SCOTTISH GAS BOARD.

RAIN water is the purest form of naturally occurring water, but even this water has dissolved the atmospheric gases. Once in contact with the earth, the water gradually dissolves other chemicals and will contain two or more of the following types of impurities:

(*a*) Dissolved gases. Carbon dioxide and oxygen, when dissolved in water, are the two atmospheric gases which are the main causes of many corrosion problems.

(*b*) Hardness. 'Hardness' is perhaps the most troublesome of all water impurities. It will cause scale formation in cooling systems and boiler plants; it reacts with soap to give an insoluble scum which adheres to goods being processed, and it may be precipitated in many processes to cause difficulties. The removal of 'hardness' is essential in many industries. It is due to soluble compounds of calcium and magnesium. Lime and magnesia are present in the earth in abundance in the form of calcium carbonate and magnesium carbonate, and are dissolved by rain water containing carbon dioxide in solution to form calcium bicarbonate and magnesium bicarbonate.

$$Ca\,CO_3 + CO_2 + H_2O = Ca(HCO_3)_2$$

The calcium and magnesium bicarbonates so produced are stable at atmospheric temperature and pressure and, being alkaline, have been termed 'alkaline hardness.' On heating a water containing these salts, the reverse of the above reaction will take place and, as the calcium carbonate so formed is very nearly insoluble in water, it may be deposited in the goods being processed or on the walls of the containing vessel. Magnesium carbonate is more soluble and is not precipitated in this way. Other calcium and magnesium salts dissolved by water from the earth are the sulphates, chlorides, and sometimes nitrates. These salts, which are not affected by heating, are neutral, or non-alkaline in reaction, and are known as 'non-alkaline hardness.'

(*c*) Other impurities. All naturally occurring waters contain chlorides. Most surface waters are low in chloride content and cause no great difficulty on this account, but underground water may contain a sufficient quantity to give rise to corrosion. Silica is present in many waters but is of significance mainly in water used for boiler feed purposes. In a boiler it may form a very hard type of scale or may act as a binding agent for other types of scale. At higher boiler pressures (600 lb. per sq. in. and upwards) silica is volatile in the steam and may pass forward in this way to cause troublesome deposits in turbines. Such deposits are formed in the medium and low pressure stage of the machine (*i.e.*—after the steam pressure has been reduced below the threshold value at which deposition of silica can take place).

Sodium sulphate and sodium nitrate may be present in water, but they have little, if any, effect on its suitability for most practical purposes. Sodium bicarbonate is often encountered in waters from underground sources, particularly waters that have passed through a bed of naturally occurring base-exchange material, *i.e.*—'greensand.' Sodium bicarbonate adds to the alkalinity of a water but not to the hardness. If a water containing sodium bicarbonate is used for boiler-feed purposes, it may give excessive alkalinities in the boiler and encourage corrosion in the steam system. Iron and manganese occur in some waters and may cause poor colour, off-shades, or spotting in textile processes, and encourage bacterial slimes in cooling systems or pipe lines.

In water treatment, the amount of impurity that has to be considered is a surprisingly small percentage of the total quantity of the water. For example, a water from a moorland drainage area may have dissolved solids of 50 p.p.m., while a water from a chalkland area may have dissolved solids of 500 p.p.m. Expressed as percentages these figures represent waters containing only 0.005% and 0.05% of impurity respectively.

Filtration in industry is employed to remove suspended matter. With the aid of suitable chemicals, known as coagulants, the process of filtration can be made to remove colour. In the preparation of water for boiler-feed purposes the removal of suspended solids is, in most cases, necessary, particularly as the pressure and the rating of the boiler increases. Suspended matter may increase the chances of feed line corrosion and will interfere with the production of clean steam. Colouring matter may interfere in the base exchange process and may reduce the life of this material.

The lime-soda process is a precipitation method of softening, in which the hardness and carbon dioxide are removed as precipitates which are then separated by sedimentation and filtration. The water is treated with hydrated lime (calcium hydroxide) and soda ash (sodium carbonate). The chemical reactions in this process are as follows:

$$Ca(HCO_3)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O$$
$$Mg(HCO_3)_2 + 2Ca(OH)_2 = Mg(OH)_2 + 2CaCO_3 + 2H_2O$$
$$CO_2 + Ca(OH)_2 = CaCO_3 + H_2O$$

In theory, therefore, the treatment of the water with hydrated lime should remove the alkaline hardness and the free carbon dioxide, by the formation of calcium carbonate. The magnesium present will be precipitated as magnesium hydroxide. Non-alkaline magnesium hardness will be replaced by an equivalent amount of non-alkaline calcium hardness.

$$Mg\begin{Bmatrix}Cl_2\\(NO_3)_2\\SO_4\end{Bmatrix} + Ca(OH)_2 = Mg(OH)_2 + Ca\begin{Bmatrix}Cl_2\\(NO_3)_2\\SO_4\end{Bmatrix}$$

The calcium non-alkaline hardness formed in this way, together with that originally present in the raw water, is removed by treatment with sodium carbonate.

$$Ca\begin{Bmatrix}Cl_2\\(NO_3)_2\\SO_4\end{Bmatrix} + Na_2CO_3 = CaCO_3 + Na_2\begin{Bmatrix}Cl_2\\(NO_3)_2\\SO_4\end{Bmatrix}$$

The non-alkaline calcium hardness is replaced by the neutral sodium salt.

In practice, the chemical reactions may not go to completion when magnesium hardness is present, unless the coagulant, sodium aluminate, is used. The amounts of coagulant used are 20-30 p.p.m. of the water being treated, and when added to the chemical mixture have the following effects:

(i) Magnesium is precipitated more efficiently, thus preventing after precipitation.
(ii) Less time is required to complete the softening reactions.
(iii) The hardness of the softened water is reduced to less than 20 p.p.m. in terms of calcium carbonate.
(iv) Sedimentation is accelerated, and a softened water of low suspended solids is passed to the filters.
(v) Silica content of the softened water is generally reduced.

A soft-water can in this way be produced with a hardness of approximately 10-20 p.p.m. in terms of calcium carbonate.

Although the removal of sodium bicarbonate is not, strictly speaking, softening, it is necessary to discuss it here, since the chemical treatment may be applied in a precipitation softening plant. If the amount of sodium carbonate produced when

sodium bicarbonate is treated with hydrated lime or sodium hydroxide, is too high for the purpose for which the water is required, the sodium bicarbonate may be removed by treatment with either calcium chloride or Epsom salts (magnesium sulphate) and converted into calcium alkaline hardness and magnesium alkaline hardness. The alkaline hardness is then removed by treatment with hydrated lime.

The efficiency of any precipitation process of water softening increases considerably with rise in temperature. This is most marked in the lower temperature range up to about 120°F. The heat may be derived from waste steam, live steam, or water drawn from the boiler, but if boiler water is returned to the softener, some modification of chemical charges will be required. Boiler water containing sodium phosphate—frequently used for boiler feed water conditioning—should not be returned to a lime-soda softener, as the presence of a trace of phosphate sometimes retards the softening reactions when the temperature at the softener is below 158°F.

The effect of sodium aluminate on the precipitation process has been referred to, but it does not give good flocculation in a water with a magnesium 'hardness' of less than 30 p.p.m. in terms of calcium carbonate—although it still speeds up the reactions and gives a softer water. Nor with partial softening does it improve flocculation unless magnesium is being precipitated. Under these conditions the new coagulant—'modified' sodium silicate (activated silica)—may be used. By producing a large floc which settles rapidly, it accelerates sedimentation. Rapid flocculation and sedimentation can be used to reduce the retention time. This is valuable where a plant has to be overloaded.

Method of Improvement

The characteristics of a softened water may be improved by the establishment, in the softener, of a blanket of sludge through which the chemicals and the water are made to pass after leaving the mixing zone. Provided no short circuiting takes place, a water of lower hardness and with less suspended solids may result.

Over the past ten to 15 years, sodium phosphate has been used for precipitation softening. Since phosphates are relatively expensive, they are used only for softening of waters low in hardness, or in a secondary softening process following lime-soda softening.

Sodium phosphate will not precipitate magnesium salts effectively, but if these are removed in a primary softener or, alternatively, if caustic soda is introduced with the phosphate, a softened water of very low residual hardness can be produced. The addition of sodium aluminate to the chemical mixture has been found to help in the production of a water of lower hardness by assisting in the removal of traces of magnesium as well as providing a flocculant. This process is usually carried out at a high temperature (about 212°F.) and, with good chemical control, a softened water with a hardness of less than 5 p.p.m. in terms of calcium carbonate is easily obtained.

This type of treatment is not yet widely used, but it may come into more general use as the steady rise in boiler operating pressure increases the need for better feed water. In America and on the Continent it is being introduced for the treatment of the feed water in the newer high-pressure boiler plants.

In the field of partial softening a new idea has been introduced by Zentner. The water to be softened is treated with the appropriate amount of lime by separately and continuously injecting raw water and milk of lime tangentially into the bottom of a thin, inverted cone partially filled with sand. The sand is kept in suspension by the flow of the water-lime mixture. The calcium alkaline hardness is precipitated and adheres to the sand particles. The retention time of the water in the plant is about ten or 15 minutes. The advantages of the Zentner process are short retention time, a clear effluent and a waste product in the form of hard particles that are easily handled. The process can be operated under a considerable head. It is usually applied, however, only to the removal of calcium alkaline hardness.

Hard waters may be softened by exchange methods of water softening. If a water containing calcium and magnesium salts in solution is passed through a bed of certain naturally occurring minerals called 'greensands,' the calcium and magnesium ions are retained by the minerals and are replaced by sodium; so that the water leaving the mineral bed contains sodium salts instead of calcium and magnesium salts. Such minerals are given the name zeolites and are, chemically, sodium-aluminium silicates. Much 'natural' zeolite is obtained from glauconite, an amorphous hydrated silicate of iron and potassium which usually contains calcium and magnesium in addition.

Very soon after the 'greensands' had proved their value, synthetic sodium-aluminium silicates were produced. These synthetic materials give a higher exchange capacity per unit weight than natural minerals. The water passed to such synthetic zeolites must have a *p*H within the range 7.0 to 8.0; outside this range the zeolites are attacked by the water, and the silica content of the treated water rises rapidly. Another restricting factor in the use of synthetic zeolites has been temperature, since the exchange material disintegrates at temperatures much above atmospheric. Recently, however, this disadvantage has been overcome and synthetic zeolites of high capacity, capable of operating at elevated temperatures, are now available.

Further research revealed that certain classes of coal, when treated with strong sulphuric acid or gaseous sulphur trioxide, yielded a product which had a high exchange capacity, did not contain silica and was not attacked by water with a *p*H above 8.0. It was also found that this material, as well as exchanging sodium for calcium and magnesium, could be made to exchange hydrogen for calcium, magnesium and sodium. Research was intensified, and synthetic resins of complex chemical structure were discovered that would replace the base (*i.e.*—the metallic radical) in a water-soluble salt with either sodium or hydrogen. Thus, if a water containing hardness and other soluble salts is passed through a bed of hydrogen exchange material, the treated water will have an acid content equivalent to the amount of salts originally present. The carbonic acid from the bicarbonates can be removed by aeration, leaving only the mineral acids. Further exchange materials were developed which had the property of removing the acid radicals, so that a stage was reached when all the usual impurities in a water, with the exception of silica, could be removed by the use of exchange materials.

Finally, materials have been developed which can extract silica from a water so that it is now possible to produce a water equivalent to distilled water by the use of a combination of exchange materials. The basis of the silica removal is the conversion of the silica to soluble hydrofluosilicic acid and its removal by the anion exchange process. A more recent method still is to remove the silica by absorption on to a strongly basic resin, which can be regenerated with sodium hydroxide.

Water in contact with the atmosphere dissolves air and the dissolved oxygen and carbon dioxide may cause the corrosion of metals.

Highly Efficient

Mechanical de-aeration is a highly efficient method of removing dissolved gases from water. There are several methods, but all depend basically on causing the water to boil. To ensure maximum efficiency, the water is made to form a thin film or a spray. Efficiencies are high and it is not unusual for the amount of dissolved oxygen in the water to be reduced to between 0.02 and 0.005 ml. per litre.

Chemical de-aeration, more correctly known as chemical deoxygenation, is normally achieved by the continuous addition of a chemical which will combine with the oxygen to take it out of solution.

Oxygen can be completely removed by the addition of sodium sulphite (Na_2SO_3) to form sodium sulphate, which is a stable chemical. It can be used to remove any concentration of oxygen from water—a frequent application is to remove the last traces of oxygen from water after mechanical deaeration. It must be continuously applied, at a point to give maximum contact time with the water and in a quantity in excess of the oxygen concentration by about 3 to 5 p.p.m. Sodium bisulphite ($NaHSO_3$), an acid salt, is also used particularly when a feed water has proved unstable on passing through an economiser and has deposited calcium carbonate. In this case the sodium bisulphite helps to retain the calcium carbonate in solution, at the same time removing the oxygen.

Carbon dioxide may be present in water in three forms: combined as normal carbonates or as bicarbonates or as free carbon dioxide. For complete removal of all the carbon dioxide it would be necessary to acidify the water with a mineral acid, followed by aeration or de-aeration. For many

purposes it is sufficient to 'fix' only the free carbon dioxide by the continuous addition of hydrated lime or sodium hydroxide.

So far, external softening has been discussed, but internal softening where all the softening reactions take place inside the boiler must be considered. By this method all the hardness salts are precipitated within the boiler in a free-flowing, non-adherent form, and are easily removed with the blowdown water. Reserves of alkali, or other precipitating chemicals, flocculants, etc., are maintained in the boiler so that the hardness is precipitated immediately on entry. Control of the chemical conditions in the boiler water is an essential part of any internal treatment. The chemistry of internal treatment may be divided into two classifications, viz., treatment with alkali and treatment with phosphate.

When a solution of sodium carbonate is heated under boiler conditions, decomposition occurs and sodium hydroxide and carbon dioxide are formed. Except under very high boiler pressures, only a portion of the sodium carbonate decomposes and, as a result, the boiler water contains a balanced mixture of sodium carbonate and sodium hydroxide—the relative proportions being determined by the boiler pressure. Conversely, sodium hydroxide and carbon dioxide may react, under boiler conditions, to form sodium carbonate. Only a portion of the sodium hydroxide takes part in the reaction so that the boiler water contains a mixture of sodium carbonate and sodium hydroxide—in fact the same equilibrium mixture as that which might be formed from sodium carbonate. Thus, when alkali is added to a boiler for internal treatment of a feed water containing bicarbonates, the boiler water will contain both sodium carbonate and sodium hydroxide, irrespective of which one is added to the boiler water initially.

Sodium hydroxide in the boiler water reacts with calcium alkaline hardness in the feed water (causing precipitation as calcium carbonate), and with all forms of magnesium hardness (causing precipitation as magnesium hydroxide). Sodium carbonate in the boiler water reacts with calcium non-alkaline hardness in the feed water, causing it to precipitate as calcium carbonate.

The maximum boiler pressure at which carbonate conditioning can be used is 180 lb. per sq. in. gauge. Above this pressure the hydrolysis of sodium carbonate to sodium hydroxide and carbon dioxide is nearing completion and there are insufficient carbonate ions present to precipitate all the calcium as calcium carbonate. Under these conditions calcium sulphate and/or calcium silicate scale will be laid down.

There are two conditions under which internal treatment with alkali may prove unsatisfactory, and in both cases phosphate treatment is used. These are when the boiler pressure exceeds 180 lb. per sq. in. gauge, and when the calcium content of the boiler feed water is low. If the boiler pressure is over 180 lb. per sq. in. gauge and given the correct conditions, sodium phosphate will precipitate all forms of calcium hardness as calcium phosphate.

$$3Ca\begin{cases}CO_3\\SO_4\\Cl_2\\(NO_3)_2\end{cases} + 2Na_3PO_4 = Ca_3(PO_4)_2 + 3NA_2\begin{cases}CO_3\\SO_4\\Cl_2\\(NO_3)_2\end{cases}$$

It is essential, however, to maintain a sufficient concentration of sodium hydroxide to precipitate the magnesium as magnesium hydroxide.

When the calcium hardness of the boiler feed water is low, a relatively large amount of sodium carbonate is required for complete precipitation of the hardness, with the result that excessive alkalinities are carried in the boiler water. Treatment with sodium phosphate is therefore employed to ensure the complete removal of calcium hardness from the boiler water, while still maintaining only moderate alkalinities.

Since internal treatment precipitates hardness inside the boiler as a sludge, this sludge must remain mobile to prevent its adherence to the boiler metal. The chemicals used to improve its mobility are tannin, starch and sodium aluminate. Sodium aluminate is particularly useful when the magnesium hardness of the feed water is more than 15% of the total. In some cases where the magnesium content is low, it is raised artificially. Tannin and starch are known to modify the type of precipitates produced, and starch is particularly useful should oil be present in the feed water.

A softening treatment may not always yield a water completely satisfactory for its purpose and the characteristics of the treated water may, therefore, have to be modified. When such modification is used to render the treated water suitable for boiler feed purposes it is known as conditioning. The term is also applied to the modification of the characteristics of a naturally occurring soft water, the purity of which approaches that of an artificially softened water.

A boiler feed water may be conditioned to protect (a) the boiler feed system, (b) the boiler or (c) the steam-condensate system. It is convenient to discuss conditioning under these three headings:

(a) *To protect the boiler feed system.*

In most low-pressure boilers, raising the *p*H of the boiler feed water will prevent corrosion or reduce it to negligible proportions. This is achieved by the addition of an alkali. In some cases, *e.g.*—when internal treatment is in use, the main boiler water treatment can be utilised to protect the feed system (and the boiler) by feeding all or part of the treatment continuously through the feed system. If treatment with alkali is not completely satisfactory, then further treatment, either mechanical or chemical, must be undertaken to remove the dissolved oxygen. With high-pressure boilers de-aeration is usually essential.

Danger of Deposition

With any water containing alkaline hardness there is a potential danger of deposition. The danger is increased by the addition to boiler feed water of chemicals such as caustic soda, sodium carbonate or sodium phosphate, and also by any rise in temperature in the boiler feed system. Deposition in the boiler feed system may be reduced or eliminated by the continuous addition of a small dosage of tannin-phosphate inhibitor.

(b) *To protect the boiler.*

The first step in preventing corrosion in boilers is to maintain an appropriate alkalinity in the boiler water. Generally, the excess of sodium hydroxide and sodium carbonate remaining after the removal of hardness in the prevention of scale provides the necessary alkalinity. If, however, it is not arrested by an adequate alkalinity, then the dissolved oxygen must be removed from the feed water before it enters the boilers.

The prevention of scale formation in boilers is usually achieved either by external softening of the feed water or by the application of internal treatment. With low-hardness feed waters treatment with sodium phosphate is applied. When water is treated to prevent scale formation and corrosion in a boiler, conditions favourable to caustic cracking (intercrystalline cracking) of the boiler metal must not be allowed to develop. The concentration of caustic soda normally recommended in a boiler water is far too small to cause caustic cracking. It will only occur with much higher concentrations of caustic soda—the result of a leakage of boiler water through seams, etc., and the concentration of the solids therein by evaporation. Moreover, the concentrated caustic soda must be in contact with highly stressed metal. These conditions are often provided in riveted seams and boiler connection joints when leakage occurs. A boiler which does not leak does not suffer from caustic cracking. The first line of defence, therefore, is to use welded or forged drums, or riveted drums which are caulked on the inside only, and to keep a sharp look out for leakage.

(c) *To protect the steam/condensate system.*

Oxygen and carbon dioxide, passing over from the boiler with the steam, cause corrosion of steam/condensate systems when they re-dissolve in the condensate. In many plants, the amount of corrosion is unimportant but, should it become serious, oxygen must be prevented from gaining access to the steam by removing dissolved oxygen from the feed water before it enters the boiler.

A recent development in the protection of condensate lines from corrosion is the use of amines, *e.g.*—cyclohexylamine, $C_6(NH_2)_6$. These are volatile, organic chemicals of an alkaline character which, when added to a boiler, pass over with the steam into the steam/condensate system. By virtue of their alkaline character they are able to raise the *p*H of the condensate to assist in the reduction or elimination of corrosion in condensate systems.

Scale formation, in the generally accepted sense, does not occur in a steam/condensate system, although severe corrosion may cause a build up of solids which has the appearance of scale. Deposition, however, can occur if carry-over takes place.

Some entrainment of boiler water with the steam occurs in all boilers. The amount is normally small, but it is measurable. Entrainment of this type causes no trouble at the temperatures and pressures encountered in normal factory boilers, though heavy carry-over can cause deposition in superheaters, and trouble with prime movers or in process work. Mechanical preventive measures are frequently used, but in those cases where the trouble is due to foaming, chemical treatment of the boiler feed water with an antifoam is advantageous. Antifoam chemicals are of a complex nature, and the mechanism by which they prevent foam formation is not precisely understood.

There is no one method of water treatment that will produce a water suitable for all purposes; even distilled water does not completely fulfil this ideal. Every process in which water is used demands certain characteristics and where specialised processes are being operated, the user should decide what impurities will influence the process with a view to drawing up a tentative specification for composition of the process water.

Basic Principles of the Law of Contract

FAILURE TO TAKE DELIVERY

By T. SOPHIAN

THE law of contract looms large in the course of conducting a manufacturing, wholesale, or retail business, and some knowledge of the basic principles of the law is desirable if the trader is to steer clear of trouble. Cases in which a retailer gives an order to a manufacturer for a number of articles, but seeks later to cancel the order, because of an 'unexpected change of circumstances, which could have resulted in his being overstocked had he taken delivery,' brings home the point very forcibly. In such a case the retailer would be held liable for not having taken delivery, and damages for breach of the contract would be awarded to the manufacturer against him. Many retailers, unfortunately, are under a misapprehension as to the extent of their legal obligations under contracts for the purchase of supplies, and accordingly we will attempt to clarify the position as between retailer and supplier. The position as between retailer and customer is basically very similar.

A contract is made by offer and acceptance. A manufacturer or wholesaler offers to sell goods of a specific description to the retailer, at a stated price, delivery to be within a stated time. The retailer accepts the offer by giving an order for the stated quantity of goods, on the supplier's terms as to price, time of delivery, etc. Thereupon the bargain is complete, and there is a binding contract.

These offers and acceptances may be by the exchange of letters between supplier and retailer, for instance, or again, they may be partly oral and partly in writing as, for instance, where a traveller calls and the retailer gives him an order which he signs. It is to be observed, however, that in order that there should be a completed contract, the parties must be agreed as to all the terms of the contract. If there is any proposed variation, there cannot be a contract, until the variation is accepted by the other contracting party.

Thus, for instance, the supplier offers to supply the retailer with goods of a certain description at a stated price, and within a certain time, after, say, one month. The retailer agrees to all the terms save the time of delivery, and requires delivery within a week. There is as yet no contract, and there will not be a contract, until the supplier has accepted the alteration as to the time of delivery, and further, notifies the retailer to that effect.

A contract, however, may be conditional. The condition subject to which the contract is made may be 'precedent' or 'subsequent.' If it is 'precedent,' the contract, although all the terms are agreed, cannot come into force until the condition has come into being. Thus the supplier and the retailer may be agreed as to all the terms, subject to a condition precedent, however, that the contract is approved of by the directors of a parent company, under whose control the retail company happens to be, the latter being a subsidiary of the former company. In such a case, until the directors of the parent company have signified their approval, the contract cannot come into being. Once the approval is given, however, the contract is of full effect, and cannot be set aside merely because the directors happen to change their minds.

A 'condition subsequent' is just the reverse of the condition precedent. The contract is already in being, but a term of the contract provides that the contract is to come to an end on the happening of a particular event. Thus, there may be a threat of strikes, with the result accordingly that delivery may be considerably delayed and other difficulties may arise with regard to the performance of the contract by one party or the other. In such circumstances, the supplier may provide that in the event of a strike occurring before the time agreed for delivery the contract is to be regarded as at an end accordingly; if a strike should occur, the contract, which up to that point of time is fully effective, would immediately cease to be operative.

One of the risks that a retailer runs when he gives orders for goods is that, owing to some unforeseen circumstances, his sales may fall short of the normal, and that he may accordingly become overstocked. This is a risk which the retailer should take into account when ordering, and it may be to his advantage to order small quantities at a time, instead of giving one or more large orders once and for all. Certainly the fact that he happens to be landed with a large quantity of unsold stock is no ground for his cancelling orders for similar stock that he may have already given, for the orders will constitute firm and binding contracts for the supply of the goods ordered and failure to take delivery of the stock will render the retailer liable for breach of contract by reason of non-acceptance. If a retailer feels that there is an appreciable risk of his being over-stocked, he should safeguard himself by appropriate provisions in the contract, that is, assuming that the supplier is prepared to accept such conditions.

There is the other side of the story, as well to be considered. The supplier, particularly if he is a manufacturer, will doubtless want to know well in advance the quantity of goods which he should manufacture. And that quantity will be measured to a large extent by the quantity of the orders received. It is self-evident, if his retailers for some unforeseen reason find themselves over-stocked with goods supplied by the manufacturer, that the manufacturer would stand to lose if he suddenly found quantities of the goods returned and dumped on him. In those cases in which retailers are allowed to cancel their orders, however, it will be generally found that the cancellation is due to the generosity of the supplier, who may well be in a position to direct the returned goods to other channels, and not due to any right vested in the retailer to cancel. However, as stated, it is up to the retailer to protect himself, if he can, by suitable conditions which will relieve him, in stated circumstances, from continuing to accept deliveries under the contract.

Where there is a breach of contract, by reason of non-acceptance of the goods, the supplier's remedy will be to recover damages for any loss that he may have suffered in consequence. These damages will usually be measured by the difference between the market and the contract price of the goods as at the date when delivery ought to have been taken. If the market price, however, happens to be higher than the contract price, then in fact no damage will have been suffered by the supplier by reason of the non-acceptance of the goods, and at most he would be entitled to nominal damages.

BROWN COAL

—its place in the future

By A. R. MYHILL,
F.R.I.C., M.Inst.Gas E., M.Inst.F.

THE serial classification of coal types from peat to anthracite is well known, although the natural processes by which coal was formed, and the manner of its metamorphosis along the series, are subjects which are still only imperfectly understood. The study of coal formation involves theories relating to chemical and physical transformations which started many millions of years ago, even before the appearance of vegetation upon the earth's crust. The potential energy of coal and its associated 'fossil' fuels has its origin in the energy of solar radiation, largely within the limits of the visible spectrum. It is considered probable that all the carbon of organic matter has been, and is being, derived from the CO_2 in the atmosphere which, at the present stage of the earth's existence, occurs to the extent of less than 0.03% by volume, while the free oxygen, now present as about 2.1%, has been and still is, produced from the CO_2 absorbed by plants in the course of forming organic matter. The relevant reactions are doubtless connected with the catalytic effects of chlorophyll in the green parts of the plants in the presence of sunlight, whereby CO_2 and water react to form aldehydic substances with the liberation of free oxygen. This may be classed as the photosynthesis stage, and is represented by the following equation:

$$nCO_2 + nH_2O \rightarrow \underset{\text{(Aldehyde)}}{(CH_2O)n} + nO_2$$

Since this action is the reverse of oxidation, it absorbs energy, and such energy contributes to the calorific value of the solid and liquid products.

The aldehydes are readily polymerised, especially in the presence of ultra-violet radiation, and form the carbohydrates, of which the pentoses (starch and cellulose) and the hexoses (glucose, etc), contribute to the trunks and stalks of the growing plants.

The polymerisation stage may be represented thus:

$$CH_2O \times 6 \rightarrow \underset{\text{(pentose)}}{C_6H_{10}O_5} + H_2O$$

What is known as 'coal' substance' approximates, in the case of a bituminous coal, to a compound having the ultimate composition C_9H_6O, and this was probably produced from cellulose ($C_6H_{10}O_5$) which has a large molecule based on an aggregation of glucose residues in chain form, by anaerobic and aerobic decay of the plant components over extremely long periods of time under the influence of heat and pressure. This stage of bacterial decay may be represented by the equation:

$$\underset{\text{(Cellulose)}}{4C_6H_{10}O_5} \rightarrow \underbrace{C_9H_6O}_{\text{(Coal substance)}} + 7CH_4 + 8CO_2 + 3H_2O$$

Since evidence must, in this investigation, be largely circumstantial, it is not surprising to find that theories of coal formation have been propounded differently by different workers, and, while it is convenient to class fossil fuels as a graduated series from peat, through bituminous coals, to anthracite, in order of geological age (viz.—peat, brown coal, lignite, bituminous coals, anthracite), direct evidence of conversion from one class to another is lacking, since such conversion must have taken place over hundreds of millions of years. Two extreme viewpoints are (a) every class of coal is regarded as an intermediate product in a continuous metamorphism, (b) each class has a different origin from plant debris or has undergone different types of treatment from that experienced by other classes. Some workers, in particular W. Fuchs,[1] have propounded the theory that brown coal and lignite represent a different line of coalification processes from that leading to bituminous coal and anthracite.[2] The theory is postulated on biochemical, rather than geochemical grounds, and states that brown coals and lignites represent the end products of a branch line in which aerobic decay predominates, whereas anthracite is the end point of another branch containing the bituminous coals in which anaerobic decomposition takes place.

The graduated variations in chemical composition of the fossil fuels is illustrated in selected data given in Table I (S. C. Ward[3]).

Less Moisture

The lignites and the brown coals are often taken as being synonymous but, strictly speaking, brown coals are somewhat geologically older than the lignites, and, whereas lignite usually exhibits the original woody structure of the ancestral plants, brown coal shows no such indications. Brown coals generally contain less moisture than lignite, although not invariably, as is shown by the examples quoted in the table. Some varieties exhibit a cleavage structure similar to that found in the true coals. It is not mechanically strong, and easily breaks down into slack on weathering. There are only very small deposits of lignite and brown coal in Great Britain, the best known being at Bovey Tracey. In other parts of the world, however, there are very extensive deposits which are important contributions to the fuel resources of the particular countries.

Tables II and III, compiled respectively by Parker[4] and Andrews[5] show the probable reserves of the true coals and brown coals and lignites in various countries.

The Australian reserves are particularly interesting in view of the great developments in the use of brown coal in that country. While the Australian reserves of total coals are not so high as those of Great Britain, they are considerably higher per head of population. Apart from the coals of New South Wales, and those in a few areas in Queensland, the remainder of the Australian coals are non-caking. The State of Victoria is dependent for most of its industrial prosperity on its brown

TABLE I—ANALYSES OF TYPICAL FOSSIL FUELS

Description of material	Water in raw material	Volatile matter 900°C. dry basis	Per cent on dry, ash-free basis					C/H ratio
			C	H	N	S	O	
Peat, Ireland	90	65	58·2	5·2	1·5	0·5	34·6	11·2
Brown coal, Australia	55	53	66·4	5·1	0·5	0·5	27·5	13·0
Brown lignite, Canada	38	45	67·8	4·3	1·0	0·5	26·4	15·8
Black lignite, Canada	16	40	72·6	4·2	2·0	0·6	20·6	17·3
Sub-bituminous, New Zealand	12	43	73·9	5·6	0·5	1·5	18·5	13·2
Bituminous, non-caking, Great Britain	14	38	75·0	5·3	1·4	1·5	16·8	14·2
Bituminous, non-caking, Great Britain	8	39	81·2	5·3	1·2	1·1	11·2	15·3
Bituminous, caking, Great Britain	4	39	84·2	5·5	1·0	1·9	7·4	15·3
Bituminous, hard coking, Great Britain	1.5	25	87·8	5·0	1·5	0·7	5·0	17·6
Semi-bituminous, Canada	—	14	89·7	4·0	1·4	1·0	3·9	22·4
Anthracite, South Wales	2	7	92·4	3·0	0·7	0·5	3·4	30·8

TABLE II—PROBABLE TOTAL RESOURCES OF COALS, BROWN COALS AND LIGNITES FOR SELECTED COUNTRIES AND POPULATIONS AS ESTIMATED FOR 1954

Country	Reserves, thousands of mill. tons		Population, millions
	Bituminous coals and anthracites	Brown coals and lignites	
U.S.A.	1,303	420	162·4
U.S.S.R.	998	202	214·5
China	1,011	1	582·6
W. Germany	224	63	49·5
U.K.	171	—	51·1
Poland	80	—	26·5
Canada	64	25	15·2
India	62	—	377·0
S. Africa	46	—	13·4
Australia	17	41	9·0

TABLE III—AUSTRALIA'S COAL RESERVES

State	Probable reserves in million tons		
	Bituminous coal	Brown and sub-bituminous coal	Total
1	2	3	4
New S. Wales	11,000	500	11,500
Victoria	12	44,000	44,012
Queensland	4,000	53	4,053
S. Australia		600	600
W. Australia		1,002	1,002
Tasmania	240	2	242
Total	15,252	46,157	61,409

coal resources, which lie mainly in the Latrobe Valley, where there is an area containing 31,000 mill. tons, the deposit being nearly 1,000 ft. in thickness in some parts.

In considering the potentialities of brown coal as a major source of heat and power, it will be helpful to compare its characteristics with those of the 'true' coals, especially in relation to gas-making and coke production.

Brown coals are characterised by a very high moisture content, which may reach over 60% in the freshly mined material, and by a high percentage of oxygen, which ranges from 25% to 30% on the dry basis. The high moisture content presents a formidable problem in its application to gas-making, and, even if it is to be used directly as a fuel, it should be consumed in the region in which it is mined, in order to avoid the high cost of transporting useless water. By partial drying and briquetting, however, a very satisfactory form of fuel may be obtained, suitable either for direct use as a fuel or for gas-making by appropriate processes. Such briquettes may contain 12% to 15% of water, and often contain as low as 2-3% of ash, calculated on the dry basis.

Attempts to make gas by carbonising the briquettes in conventional forms of retorts have not generally been found to be satisfactory, the yield of gas per ton being small, and its calorific value low. These results are what would be expected from a substance having a very high oxygen content. The volatile matter consists largely of CO_2, which is evolved as about 25% by volume of the gas. Methods of increasing the calorific-value of the latter by removing the carbon dioxide at atmospheric pressure, using potassium carbonate as absorbent, have been found to be very costly in operation. Moreover, carbonisation does not produce a coherent coke, but a soft, friable 'char,' which is highly reactive, not readily saleable, and presents difficulties in storage and transport.

A considerable amount of work has been carried out in examining the possibilities of water gas production from brown coal, and investigations have included straight blue gas production, carburation with oil, and water gas production plus carbonisation in one unit.[5] In all these cases the results were unsatisfactory and the conclusion was reached that the normal water gas plant, operating on the blow run principle, is unsuitable for the gasification of brown coal briquettes. One of the main drawbacks was the blockage of the fuel bed after comparatively short periods, due to disintegration of the briquettes. Very considerable losses of carbon occurred by removal with the ash, and by carry-over to the stack. Low air-blasting rates were necessary on account of the friability of the fuel, and, since the rate of gasification is an important factor in the economics of the water gas process, it became obvious that the proposition was not commercially practicable.

Although the properties of brown coal are not such as to lend themselves to economic gas manufacture by 'conventional' processes, its high reactivity favours the use of some of the more recent processes of total gasification, in particular, the Lurgi process which operates at high pressures (*e.g.*, 25-30 atm.) using superheated steam and oxygen as gasification media.

Difficult to Estimate

The Lurgi process has been operating in Germany and other countries for a considerable number of years, but, until recently it has always been used in association with other manufacturing processes, and not as a single gas-making unit, so that it has been difficult to estimate the thermal efficiency which might be obtainable on a large unit designed primarily for gas manufacture. In Germany, integration of works power as a whole, coupled with the very low cost of raw material, has not led to the full use of heat recovery which might be obtained in independent gas-making installations, and it is likely that, by making use of such economies, considerably higher thermal efficiencies will be achieved in the future.

The reactions involved in the Lurgi process are:—

(1) Combustion of carbon direct to CO_2 at the base of the generator :— $C + O_2 = CO_2$
(2) Formation of CO from CO_2 and carbon :— $CO_2 + C = 2CO$
(3) The 'high temperature' water gas reaction :— $C + H_2O = CO + H_2$
(4) The 'water-gas shift' reaction :— $CO + H_2O = CO_2 + H_2$
(5) Hydrogenation reactions to form methane :—
(a) $C + 2H_2 = CH_4$ (probably the dominant reaction)
(b) $CO + 3H_2 = CH_4 + H_2O$
(c) $2CO + 2H_2 = CH_4 + CO_2$

Hydrogen is produced by carbonisation of the coal substance in addition to that produced by the above reactions, as are also methane, ethane and other hydrocarbons.

The calorific value of Lurgi gas made from brown coal operating at pressures up to 25 atm. is generally lower than that of normal town gas as distributed in this country, being of the order of 390-410 B.Th.U. per cu.ft. Its value, however, depends to a very large degree on the composition of the raw material and on its chemical activity, and in some cases reaches 450 C.V. or above. Interesting possibilities are foreshadowed in respect of control of calorific value by regulation of the methane content of the gas. There are several ways in which it is possible to increase the methane content:—

(a) By increasing the working pressure. Thus, an increase from 10 atm. to 40 atm. was found to increase the calorific value by about 60 B.Th.U. per cu.ft.

(b) By reducing the rate of travel of the gases, which, in effect, means increasing time contact. Since, for a given output rate this would very materially increase the amount of plant required, it is questionable whether the advantages gained would compensate for increases in capital costs.

(c) By modifying the process to increase the partial pressure of hydrogen in the upper zones of the generator, where methane formation is limited by the presence of large proportions of carbon dioxide and undecomposed steam. This can be achieved by dividing the process into two stages, each conducted under optimum conditions. The generator is separated into two zones, represented by the predominating reactions. The upper zone is the hydrogenation or methane-forming section. The lower zone is the section where carbon dioxide, carbon monoxide and hydrogen predominate, together with undecomposed steam. Arrangements are made whereby

a considerable and controllable proportion of these latter gases can be removed at this stage, the water vapour condensed and the CO_2 absorbed by washing, and the gas re-introduced in a pre-heated state at the lower part of the upper zone, thus maintaining an augmented partial pressure of hydrogen in the methane-formation zone.

Modifications as described are under investigation and encouraging preliminary results have been obtained.[6] Although the conventional method of gasifying brown coal by the Lurgi process at present operates with briquettes on a fixed fuel bed, methods are being tried on the experimental scale to use dry powdered material, used as a true 'fluidisation' process or by special methods of entrainment of the powder in the gasifying medium. Whatever methods are used, the Lurgi system, in common with other high pressure processes, possesses very great advantages in gas purification, due to the greater solubilities and heat transfer coefficients of the products which have to be removed. Purifying vessels are much smaller than those used in conventional plant operating at approximately atmospheric pressures. Carbon dioxide (which in the production of brown-coal gas is formed in much greater amounts than in coal carbonisation or water gas production) must be removed, and this is done by simple water washing under the prevailing pressure, as is also the bulk of the hydrogen sulphide and other sulphur compounds. The necessary high pressure is also available for economic storage and distribution of the purified gas.

Although brown coal has been used for many years as a gas-making material in Europe, its possibilities have yet to be fully implemented, especially in other countries which have large deposits. As an example, the position of the gas industry in Victoria, Australia, is an outstanding case. In this large area it is planned to gasify brown coal by the Lurgi process on the field at Morwell, 93 miles from Melbourne, and, later, at other stations in the Latrobe Valley, for supplying the city of Melbourne and other towns along the pipeline. On November 29, 1956, the first gas entered the system and the project was officially declared open by the Duke of Edinburgh. The gas made is delivered (after purification from CO_2) at a calorific value of 450 B.Th.U. per cu.ft. and has combustion characteristics suitable for normal types of gas appliances.[5]

Fundamental Reactions

Synthesis of organic compounds from carbonaceous materials, although often very complicated in practice, especially in the final stages, is based on a few simple fundamental reactions leading to the formation of precursors such as H_2, CH_4, CO, CO_2, N_2, C_2H_2, and other simple molecules capable of being transformed by well known chemical reactions into almost any desired organic substances. It has, in fact, been stated that it is possible to make any organic compound by starting with carbon, air, and steam and, in principle, this is undoubtedly true (with the possible exceptions of certain organic substances containing 'inorganic' atoms). The cost of doing this, however, may, or may not, rule out many theoretically possible schemes. Among the possible processes suitable for the production of precursors for organic synthesis, may be mentioned those of Lurgi and Winkler.

The modern Lurgi plant has the potentialities therefore, not only of a gas-making unit, but as a starting point for making many chemical products, if their production by such means is found to be a commercial proposition. Andrews[5] states that the Morwell Lurgi plant produces the cheapest hydrogen, carbon monoxide, nitrogen, and carbon dioxide in Australia. These substances offer possibilities for the synthesis of ammonia, urea, methanol and many other chemicals as well as of liquid fuel products.

At Morwell, the maintenance of sufficiently high calorific value of the gas produced, is a very serious consideration, particularly as, in the near future, enrichment of the town supply by gas made from bituminous coal and by oil-refinery gas will eventually be discontinued. The methane content of the gas must therefore be retained, but the removal of those constituents possessing low calorific values, for the synthesis of marketable products is an avenue which is under consideration.

The Winkler process in its various modifications[8] has been used as a source of 'synthesis gas' (*i.e.*—a mixture consisting essentially of hydrogen and carbon monoxide) from brown coal and lignite, for many years in Germany. This process has the advantage that it can be used for the gasification of dried brown coal which has a high ash content. It will also deal successfully with a powdery coke known as 'grude', obtained by carbonising brown coal.

The Winkler method is of comparatively low thermal efficiency on account of loss of carbon in fly ash and generator clinker, but for inferior types of brown coal obtained cheaply by surface mining, its adoption is a proved commercial possibility. In this process a 'boiling-bed' generator is used, containing the fuel ground to about 3 mm. size. The fuel is gas-borne, and behaves very much like a boiling liquid. The fuel bed finds its own level, and circulation of the particles produces substantially even temperature distribution within the bed. The fuel is introduced into the generator by means of a water-jacketed screw conveyor, and a blast of steam and oxygen is passed in through tuyeres fitted in the conical bottom of the chamber. Below the tuyere level is the grate, and immediately above the grate is a water-cooled stirrer arm which sweeps the larger lumps of clinker towards discharge holes, where they are mechanically moved by means of screw conveyors.

As an example, the gasification of 'grude' produces a gas containing approximately 20% CO_2, 35-40% carbon monoxide and 40% hydrogen.

Development Stage

The Fischer-Tropsch process is only in the development stage, and operates with several modifications of the original plan, appears likely to be a highly successful method for producing those products which are known as 'intermediates' and which occupy a position between the precursors and the final synthetic products. It is a process which appears particularly applicable to the gas produced by the Lurgi or Winkler methods from brown coal. The basis of the process is the catalytic hydrogenation of carbon monoxide, under pressures which range from atmospheric to 2,200 lb. per sq. in., or more. A very important feature of the Fischer-Tropsch synthesis is that the process is capable of great variation to produce a variety of products at will from a given basic material.

The products are, in general, aliphatic, but the process can be operated in conjunction with the conversion of the aliphatic compounds into aromatics by cracking, as in the petroleum industry.

Typical Fischer-Tropsch reactions leading to the formation of paraffins and olefines are given below:—

$$nCO + (2n+1)\,H_2 = \underbrace{C_n H_{(2n+2)}}_{\text{Paraffins}} + nH_2O$$

$$nCO + 2nH_2 = \underbrace{C_n H_{2n}}_{\text{Olefines}} + nH_2O$$

$$2nCO + nH_2 = \underbrace{C_n H_{2n}}_{\text{Olefines}} + nCO_2$$

A number of different substances have been used as catalysts.

During the war, German plants, operating at atmospheric pressure used a cobalt-thoria catalyst. An iron catalyst has recently been developed which shows great promise for plants working at over 20 atmospheres pressure. This material permits of an output seven times greater per unit weight of catalyst than the older cobalt-thoria mixtures. A difficulty which presents itself with many catalytic processes is the 'poisoning' of the catalyst by certain impurities in the gases used, particularly sulphur compounds.

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GAS ON THE CONTINENT

Production of Synthesis Gas in Continuous Vertical Chambers

THE difficulties and eventual success in the economic carbonisation of weekly- or non-caking Japanese coals in 1934 in an installation of continuous vertical chamber ovens for the production of synthesis gas is described in the November 22, 1957, issue of *Das Gas-und Wasserfach* by Wilhelm Fitz. An industrial installation, now in operation, comprising 68 chambers and using 600 tons per day of Japanese *Ube* coal, is claimed to be the largest installation of its kind in the world. Operating results in this plant together with gas purification and treatment leading up to the synthesis of ammonia, and details of by-product recovery are described.

The development of the continuous vertical chamber oven is traced to the early work by Woodall-Duckham and Glover-West, and the early introduction of CVRs, in England when compared with Continental Europe is noted.

Following a suggestion made by Sir Arthur Duckham, Heinrich Koppers seized upon the idea of up-ending his coke-oven to the vertical. While acknowledging the advantage of the new oven system he endeavoured to improve on the English retort-ovens. Instead of recuperators he used regenerators in the heating system. Even heating over the full height was achieved by alternately heating upwards and downwards, and by decreasing the vertical taper of the chamber it was possible to improve the quality of the coke at the same time providing sufficiently high temperatures at the lower end (base) of the chamber for the production of water-gas by the reaction of steam on the hot coke. A further improvement was the introduction of a special feeding tube which directed the incoming cold coal immediately to the high temperature zone thus eliminating the sticking of coal in the plastic stage to the wall of the chamber.

The first test plant was erected in Berlin (Tegel) in 1912 and results were completely satisfactory—the first world war intervened but in 1920 plants were built in Germany, Holland, Austria, Poland, and England. In 1928 ovens of this basic design were applied to the making of special electrode coke.

At that time Japan faced the problem of having to produce gas for the synthesis of ammonia from non-caking coals. Japanese coals, compared with European and American coals, are young, high in volatile matter, sulphur, and finely distributed ash (the ash having an extremely low melting point) with calorific values of 5,700 kcal per kg and some even as low as 3,600 kcal per kg, and having a fixed carbon content of 35.1% down to 18.1%.

Expected Yield

In 1932 the Japanese Company, Ube Chisso Kogyo, began the planning of an installation to deal with Itsudan and Ube coals. The Company eventually got into touch with Koppers at Essen who offered their continuous vertical chamber oven for this duty. In view of the low melting point of the ash of these coals the average combustion chamber temperature was limited to 1,000°C. Following laboratory tests on the Ube coal it was considered that a yield of about 1,000 cu. m. per tonne of distillation and water-gas could be expected. The reactivity of the low-temperature coke was good and promised a high percentage of conversion of the steam and consequently a high produtcion of water-gas at the base of the chambers even at this relatively low temperature.

As there was no other possibility of using the tar at that time, it was to be sprayed back into the retorts thus slightly increasing the gas yield. The coke extracted from the chambers was to be used in normal mechanical producers for heating the oven installation and the breeze would be available for steam raising.

In 1933 an order was placed with the Koppers Company for the erection of 16 continuously operated vertical chamber ovens, arranged in four benches each of four ovens for a daily gas production of 122,000 cu. m. together with a mechanical producer plant.

The oven resembled basically the continuously operated vertical chamber oven for gasworks. The coal which was fed periodically from the bunkers into the coal feed-hopper gravitated continuously into the chamber at a carbonising speed regulated by the coke extractor-gear. Superheated steam for cooling the coke and for the formation of water-gas was injected above the extractor-gear and the mixed gas was drawn off through the offtake-pipe at top-of-stack level. The coke is discharged intermittently through hydraulically-operated doors into coke wagons.

The chambers are heated on both sides by combustion chambers each heating two adjacent ovens. Each combustion chamber was divided into eight vertical flues arranged for periodical change-over of heating from upwards to downwards. Producer gas and air being pre-heated in regenerators, the regenerators were arranged one above the other so that the top regenerator serves for the pre-heating of air and producer-gas while the sensible heat of the waste gas is stored in the lower one. The heating-direction was changed over every thirty minutes.

Height Increased

Heating-gas and air are pre-heated to 1,000°C. in the regenerators. The temperature of waste-gas at the outlet of the regenerators was below 300°C. Deviating from the normal gasworks practice for continuous vertical chambers the height of the chamber was increased to 9.5m. and the taper of the chamber decreased because of the non-caking character of the coal. The oven then being 9.5 m. high by 3.5 m. long by 300 mm. wide.

The coal itself is gasified in the upper half of the chamber while the residual semi-coke in the bottom half is partially converted to water-gas by the injected steam. Combustion chamber temperatures are limited to 1,200°C. because of the low melting point of the ash. In practice the temperature was reduced to prevent difficulties caused by slag-formation without appreciably reducing water-gas production. Producer gas is generated from the screened semi-coke in mechanical producers of Koppers design with low pressure steam production. The producers are provided with fuel grading plant so that small coke can also be gasified.

The plant was put into operation in April, 1934, and was extended by 16 chambers in 1935 and a further 36 chambers in 1936 so that when the installation was completed there were 68 chambers with a total daily output of 520,000 cu. m. synthesis gas.

While water-gas is formed in the bottom portion of the chamber, carbonisation of the coal takes place in the upper third as is shown by the ascending methane-content. It is a surprising fact that only about one third of the chamber is required for carbonisation while two thirds of the height of the chamber are available for water-gas manufacture.

The following table gives the analysis of the coal used and semi-coke made in the plant together with yields of gas, semi-coke, tar and liquor.

Coal analysis:		
	Moisture	10%
	Ash	17%
	Volatiles	40%
	Cal. val.	5,450 kcal/kg.
Gas per tonne of coal		980 m³
Semi-coke „ „		0.38 tonnes
Analysis:		
	Moisture	7.8%
	Ash	49.6%
	Volatiles	3.6%
	Cal. val.	3,400 kcal/kg.
Tar per tonne of coal		0.095 tonnes
Liquor „ „		0.2 tonnes

About two thirds of the coke discharged is utilised for manufacture of producer gas and for blowing with oxygen. The remainder, including all the breeze, is used in the boiler-house for steam-raising. The vertical oven gas is cleaned of tar by condensation and of light oils by oil washing. Hydrogen sulphide is removed in the Thylox process and the gas is dehydrated.

That portion of the semi-coke not used for heating the ovens or in power generation is gasified in generators with oxygen and steam, producing gas with CO_2 26.0%, CO 29.5%, H_2 41.5%, CH_4 1.0%, N_2 2.0%. This gas is treated in a Seaboard plant, passed through dry purifiers and then mixed with the oven-gas. A small quantity of the coal is also gasified with oxygen. The mixture of the three gases, of which about 70% is oven-gas, has the composition: CO_2 13.1%, C_nH_m and O_2 1.0%, CO 29.7%, H_2 46.1%, CH_4 6.7%, N_2 3.4%. The mixture is finally converted into synthesis gas by converting the CO into CO_2 and removing the latter by washing at 12 atmospheres in water and a solution of sodium carbonate.

The CO_2-free gas is cracked by deep-refrigeration in a Linde plant. The residual gas, consisting mainly of carbon monoxide and methane, is used to supplement the producer gas in heating the ovens. The main stream is mixed in the ratio of 3 to 1 hydrogen to nitrogen from liquefied air, compressed to 250 atmospheres and converted to ammonia by the Fausser-method.

From each tonne of Ube coal carbonised 0.42 tonnes of ammonia is recovered. The ammonia is mostly used for the production of ammonium sulphate; a small quantity is used for the production of the nitrate, while the CO_2 from the washing of the synthesis gas is converted to ammonium bicarbonate.

Other by-products of the carbonisation of coal are also recovered. The tar is cracked into a waxy distillate and pitch by distillation in middle oils from which cresol, creosote and xylenol are also recovered. From the waxy distillate cresol and paraffins are recovered, with finally resins and dyes. It is interesting to note that since 1951 cyclohexanol caprolactum, the raw material for the production of nylon, has been obtained from the ammonium bicarbonate/hydroxylamine reaction.

Exhaust Valves for Industrial Gas-fired Installations

IT is now common practice to install a flap valve in the exhaust duct from gas water heaters and other similar plants. Such flap valves are automatically operated by heat-sensitive devices, so that they open when the gas heater is in operation and close as soon as the heater is shut down. This prevents loss of heat from the surrounding space by the convection draft of the hot exhaust ducts. These thermally controlled flap valves, however, are not suitable for many large industrial installations.

In many commercial plants the thermal capacity of the plant itself is not negligible and in fact stores large quantities of heat in itself against sudden demand. With these, a continuous natural draft would occur in the absence of some restriction in the exhaust ducts and a very large proportion of the stored heat would be lost. In due course the temperature would fall to the value where the gas burners would again come into operation and the whole process would thus be repeated. Research over several years by the author and G. Kromschröder A.G., of Osnabrück, has developed a series of exhaust valves and complete systems specially suited for industrial gas-fired plants. It is not intended that this article should deal with all the many varied schemes which may occur, this can best be done by consultation with the supplier in each case.

Fig. 1 shows a typical simple installation. On opening the main gas cock, gas pressure is supplied to connection A of the control valve C, holding the flap valve closed. When the ignition safety device operates and the control valve opens to permit the gas to flow to the burners, the gas pressure can also pass through connection A of the control valve C. This acts on the diaphragm B and opens the flap valve D. Schemes have also been developed in which the control of the exhaust valve is electric, and the control is by a thermostat or where the flame-sensing device is electrically operated.

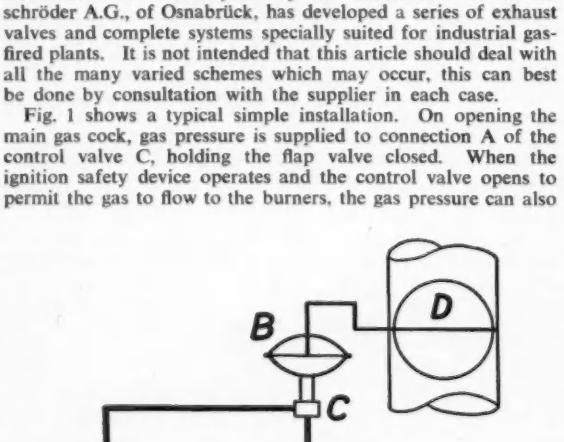


Fig. 1. Gas burner with pressure regulator, ignition safety device, control valve and flame-sensing device. A and A', connections for control lines; B, operating cylinder; C, control valve; D, exhaust flap valve.

In considering the installing of exhaust valves in a gas-fired plant, the user should consider what saving will be made by installing them and what the capital cost would be. Where the plant is operated continuously at full load clearly no exhaust valve is needed. Practical experience shows that the losses can be 15-40% of the heat used and the installation cost of the exhaust valves can be recovered within a few months or at the most a year.

A. Drevmayer. *Gas-Warme*, Vol. 6, No. 8, August, 1957. p. 274, 3 pp.; 3ff

Research into Infra-red Drying in Germany

TESTS carried out on paint pigments which had been precipitated and filter-press dried under normal commercial conditions, to give a pigment containing approximately 60% of water, are described by H. H. Müller in an article in the September, 1957, issue of *Gas-Wärme*. The drying tests were carried out with a flameless low-temperature emitter made by the firm of Gogas, operating at 150-450°C., i.e., in the invisible region, and a high-temperature emitter operating on the Schwank system at 700-900°C. The second unit burns premixed gas and air to heat a ceramic plate.

The infra-red emitters were mounted on a frame in an oven which could be set at different distances from the sample. The front and back of the oven were made removable and the air was admitted through slots on both sides. In order to provide a uniform distribution of the air in the space before the openings, it was filled with Raschig rings. The sample was placed on a metal plate, supported on a weighbeam. The air supply was measured with an orifice and the gas by a meter. To measure the temperature of the sample, thermocouples were distributed over the sample, not in contact with the metal plate.

The purpose of the tests was to show how much air is required in infra-red drying, not as a heat transfer agent, but only to remove the vaporised water. Theoretically only a minimum quantity of air is needed, and any excess has no influence on the drying process but merely entails a loss of heat.

The sample of approx. 2.5 kg. (5.5 lb.) wet weight was placed in a layer approx. 10 mm. (.39 in.) thick and irradiated from distances of 29-65 cm. (11.31—25.45 in.). Despite some difficulties due to the variation of atmospheric relative humidity, the tests showed that the best values of drying time and gas consumption were with the minimum distance. This resulted in a gas consumption of 2.5 cu. m. per kg. (40.11

cu.ft. per lb.) of dry pigment and 2.61 kg. wet charge, i.e., 1.16 kg. dry weight required 85 minutes.

The rate of evaporation decreases as the drying progresses, and unless the sample is turned over during the test, which would best be done after 80% of the moisture has been driven off, the last 20% of the drying requires some 50% of the gas consumption and time.

The values obtained compare with values from a West German paint factory with steam-heated chambers where for a wet charge of 8.3 tons to give a dry output of 3.5 tons of pigment requires 28 tons of coal. This is an average summer value and is equivalent to 8.5 kg. of coal per kg. dry pigment, giving a clear indication of the relative economy of the infra-red process.

Influence of Air-steam Mixture in Producer Gas Plants

AN important point in the production of producer gas is the maintenance of a thermal balance between the endothermic and exothermic reactions. This requires that all heat losses from radiation, conduction, etc., from the plant and the sensible heat of the gas must also be made up by the burning of the carbon in the oxygen available. Normally the control is based on saturation of the air supplied at a given temperature, usually 58-60°C. The purpose of the test reported here was to investigate the effect of this air-steam mixture on the properties of the gas.

The plant used was a small dual-purpose generator of the Gaswärme Institute in Essen. The generator itself was a small grateless shaft type of 30 cm. (11.7 in.) diameter and 150 cm. (58.5 in.) effective height, consisting of a steel body with brick lining. It was provided with a vertical contra-flow washer-cooler filled with Raschig rings, a bog-ore sulphur removal unit and a gas storage vessel, which cannot, however, be used with producer-gas operation because of insufficient pressure. The air is supplied by a blower; all air and gas flow measurements during the tests were by orifices.

The steam is normally supplied by a L.P. boiler at 0.2-0.3 atmosphere (2.9-4.4 lb. per sq. in.), but because of difficulties of measuring such steam, an intermittent steam generator, with water level indication, was used for these tests. The normal capacity of the plant is 10 cu. m. gas per hour (353 cu.ft. per hour).

During the tests, the air rate was kept at 14.35 cu. m. per hour (506.5 cu. ft. per hour), giving, with the bed used, a pressure before the bed of 350 mm. (13.6 in.) W.G. The steam was maintained at 106°C. and 1.3 atmospheres (19.1 lb. per sq. in.) and the rate of supply of the steam controlled on the air-steam mixture temperature. Tests were made with temperatures between 50°C., below which the ash tends to melt, to 70°C., above which the reaction ceases. The coke used was of size between 5 and 10 mm. (.2 and .4 in.) and had an ash content of 9% and a 1.6% water content. Results show clearly how the CO_2 content increases with increased steam supply, but at the same time the calorific value increases because of the higher hydrogen content of the producer gas.

H. H. Muller, *Gas-Warme*, Vol. 6, No. 8, August, 1957. p. 276; 3 pp.; 3 ff.; 1 g.; 2 t.

Leak Detection

METAL AND PIPELINE ENDURANCE LTD., report the successful conclusion of a particularly difficult leak detection service on the newly constructed Shellhaven-Romford gas main. In a recent paper to the Institution of Gas Engineers, on November 20, 1957, Mr. A. D. L. Copp, Distributing Engineer of the North Thames Gas Board, reported that there were five air test failures in the 20 sections of this 24 in. diameter welded steel line, 15½ miles long between Shellhaven and Romford. There were no leaks on the butt welds which were supervised by the MAPEL welding inspection service using ultrasonic and gamma ray tests but on longitudinal welds there were five very small leaks each about two cu.ft. per hour at 100 lb. per sq. in. air test pressure.

The tolerance specification by the clients varied from 0.018 to 0.033 lb. per sq. in. fall in pressure over 24 hours (measured of course with a dead weight tester) according to length under test. A fall in pressure of 0.033 lb. per sq. in. corresponds with an air temperature drop of approximately one-fifth of a degree Fahrenheit, but the fall was continuous over several days and it was therefore determined that leak detection should proceed. The method consists in pressurising the length of main under test with air, mixed with carbon tetrachloride, through a patented dispenser; bar-holing down to the already back-filled pipe and testing for any trace of carbon tetrachloride at the bar holes with a highly sensitive electrical detector. The skill of the trained operator contributes largely to success. The availability of this MAPEL service enables contractors laying new mains to back-fill their trenches with confidence that if the main does not pass its air pressure test, the leaks can be found.

Further particulars may be obtained from Metal and Pipeline Endurance Limited, Artillery Mansions, Victoria Street, S.W.1.

The Copper Journal

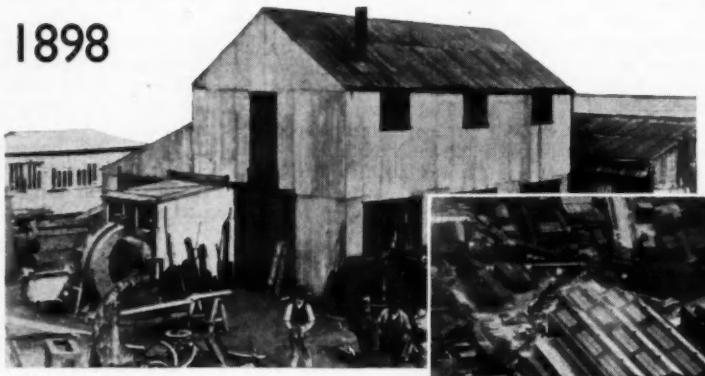
A WELCOME newcomer to Britain's technical publications is the *Journal of the Copper Development Association*, edited by Len Adams. The Copper Development Association is a non-trading organisation whose aim is the extension and improvement of existing applications of copper and copper alloys and the development of new uses. It provides a link between research and industry. Its services, which are available to all without charge, provide technical information and advice, and a wide range of useful publications. Sponsored by the copper industry, the Association is represented on many committees of the British Standards Institution and other development organisations. It maintains close contact with similar associations in Europe and America, including the recently formed International Wrought Non-Ferrous Metals Council.

During the past 12 months the Copper Development Association has undergone greater changes than at any time during its previous 24 years of existence. It has moved into new, larger, and more central premises in the middle of London; it has acquired a new director and has enlarged its staff to cater for the increased scope of its work. Its revenue has been increased to match the ever-widening scope of its activities. It has broadened the representation on its management committee and has embarked on a new policy of co-operation internationally with other development associations in the copper field.

The appearance of this magazine is another new departure for the Association. It will be produced at regular intervals and is expected to convey to readers in an interesting form some features of the work of the Association and of new developments to the industry. The field for the development of copper is as great as ever and there are few who would disagree with the general view that copper has a great future. The Association exists for the purpose of helping all users of copper to make the best applications of this versatile metal. The Association makes no charges for its services; it is supported by all branches of the copper-producing and fabricating industry and exists purely for the purpose of serving the industry on a technical basis.

Features of this first edition of the new publication include 'Copper and its Alloys,' briefly describing the grades of copper commercially available; 'Copper and Fashion'—since the time of the earliest cultured Egyptians, women have adorned themselves with jewellery made from copper, bronze, and brass; 'History in Bronze'—a decorative frieze made of cast aluminium bronze and weighing nearly three tons makes an attractive feature in a new Liverpool restaurant; 'News in Brief,' describing submarine telephone cables; Institute of Metals symposium; and compliments from an inmate in one of H.M. prisons; and C.D.A. publications, giving a revised list of C.D.A. publications, covering a wide range of subjects dealing with copper, recently much extended.

TRADE NEWS



Sixty Years of Expansion—the Story of Broom & Wade

Top left is a picture taken in the early days; below, an aerial shot of the Broom & Wade factory at High Wycombe as it is now.

IT was in 1898 that Broom & Wade Ltd., of High Wycombe, founded by Mr. Henry S. Broom, began to manufacture air compressors and pneumatic tools. In 60 years there has been continuous expansion so that, from a modest payroll of 12, the firm now employs 1,400. In the last 30 years the expansion has been most marked; floor space has trebled since 1928 and turnover has increased by 250% since 1949, of which export orders account for 50%. Today the organisation is the largest of its kind in Europe, manufacturing only compressed air equipment, and employs agents in 100 countries.

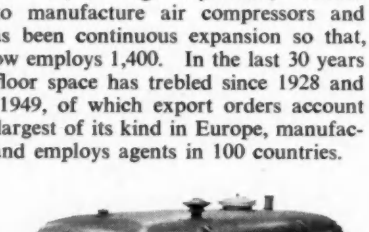
The products of the firm, under the trade name of 'Broomwade,' cover a wide range from stationary and portable compressors to pneumatic tools of all types and a light-weight pneumatic hoist.

For the Gas Industry

These products are of considerable interest to the gas industry. The portable compressors, together with the firm's pneumatic drills, can find considerable use in the distribution engineer's department, while the hoist and perhaps some of the light pneumatic tools, power drills of all sizes and power driven screwdrivers, will find use in the maintenance departments of production stations, the industry's garages and motor transport repair shops.

Severe Conditions

Among the developments of air compressing equipment brought about by the firm in recent years, are, in the stationary compressor range, the dry cylinder, carbon ring type, designed to deliver oil-free air, and in the portable compressors range the Broomwade oil-cooled rotary compressor. In this latter type of equipment, the many difficulties and problems that presented themselves were overcome after long trials under the most severe working conditions before it was put on the market.



The Broomwade WR 120 rotary compressor diesel.

After tests in Canada working at −10°F. alternating with conditions similar to the tropics and lasting 1,000 hours, no wear could be found when the compressor was dismantled. The design of this compressor includes a low pressure and a high pressure stage, set side by side with the stators integrally cast in one piece. The rotors are manufactured from 38/40 tons tensile steel and are slotted to take non-metallic blades.

By using a system of flood lubrication whereby oil is continuously pumped into the high and low pressure stators through slots, the clearances between rotor and stator need not be as fine as in such systems lubricated by more conventional means, nor is there any excessive wear on the rotor blade tips. Both rotors are mounted in ballbearings and are geared together by precision-cut hardened gears, accommodated in a separate casing and lubricated by a similar oil to that used in the stators. Oil from the stators, which cools the air being compressed as well as lubricating the unit, is circulated through a cooling system mounted near the engine cooling-water system.

Optimum Value

Power from the engine is transmitted to the L.P. rotor through an internal and external gear type coupling, which removes any possibility of thrust being exerted on the rotor. Gear type oil pumps for circulating the cooling and lubricating oil are fitted to the end of the H.P. rotor. A by-pass is fitted to the oil circulating system to allow the temperature of the oil to reach the optimum value and is operated automatically.

These compressors are made in three sizes, 120 cu.ft. of free air per minute at 100 lb. per sq. in., 250 cu.ft. per minute, and 630 cu.ft. per minute. For the smallest size the drive can be either petrol or diesel engine, with only diesel drive for the two larger sizes. The

chassis and body work are of modern design and have attractive lines.

Recently an agreement has been reached between Broom & Wade Ltd., and the Avo Corporation of Bryan, Ohio, U.S.A., who are the leading designers and manufacturers of pneumatic tools in America, for the manufacture in England of a range of pneumatic tools of new design and high efficiency. These include the Avo-Broomwade pneumatic hoist, capable of lifting half a ton and at a speed of 25 ft. per minute and weighing only 29 lb.—*Broom & Wade, Ltd., High Wycombe, Bucks.*

Power-Gas Fume and Dust Filter

THE Favorit filter process, which can be successfully used for the recovery of dust and fume, consists of a number of compartments, containing fabric filter sleeves, which are connected in parallel by means of manifolds and valves. Gases to be filtered enter the compartments via the inlet manifold and pass through the filter sleeves where the dust or fumes adhere to the inside surface.

Cleaned gases are drawn through the outlet valves and the outlet manifold by the exhaust fan and sent to atmosphere.

In order to preserve a constant pressure drop across the filter system each compartment in turn is isolated from the system by closing the outlet valves and the accumulated material is shaken from sleeves into a hopper, from which it is removed periodically by discharge valve or continuously by screw or other suitable conveyor. During this cleaning period a current of conditioned air or gas is passed through the sleeve in reverse direction to the normal flow. This prevents the passage of dust through the fabric into the dust-free side of the plant. The whole system is driven by one electric motor and no compressed air or additional electrical equipment is required.—*The Power-Gas Corporation, Ltd., Stockton-on-Tees.*

◀*The new Bratt Colbran Kingsbury gas fire. Its overall height is 27 in.; width (excluding tap fan), 19 in.; depth, 7 in.; height of flue spigot 18 in. Its rated heat input is 16,000 B.Th.U. per hour (32 cu.ft. per hour, C.V.500). Finishes in gold and bronze, cream and bronze, all bronze, and pewter and black.*

The Chaseside Loadmaster '800TC' was introduced in October, 1956, since when large numbers have been sold overseas. It is said to be the first British loading shovel to incorporate torque converter transmission. Since then minor modifications have been made to the machine: A new square edged scoop with a manganese steel toeplate and teeth is used on the current machine and the driver's entry is now through the rear of the cab. Other features remain the same including the power crowd and 9,000 lb. pryout force at the toeplate.—Chaseside Engineering Co., Ltd., Station Works, Hertford, Herts.

Idea for New Dew-point Meter Came from U.S.

A PRECISION instrument for the measurement of water vapour density and water vapour pressure, proportion of water vapour by volume and dew-points, is now being manufactured under contract in this country by C. F. Casella & Co.

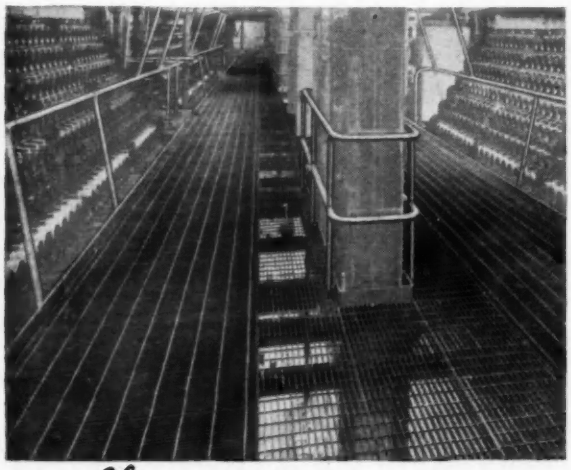
The instrument is suitable for testing in many chemical manufacturing processes, plastics manufacture, air-conditioning and refrigeration installations, and can be employed in the measurement of furnace atmospheres for bright annealing, carburising, carbo-nitriding and bright-hardening where the water vapour content of the furnace atmosphere and the atmosphere delivered from the gas generators is of first importance. In this application, the suitability of an atmosphere is very often assessed in terms of dew-point.

Called the Alnor dewpoint meter, this is a portable, self-contained instrument, manually operated and designed for the measurement of the water vapour content of air or any other gas which has a dew-point within the range −80°F. to room temperature. It was developed originally by the Illinois Testing Laboratories Inc. of Chicago for the testing of gases that are relatively dry and therefore within the dew-point range where most other methods of measurement become difficult or impossible.

The apparatus operates on the well-known principle that if a gas is compressed and the pressure released, the consequent expansion results in a cooling effect. If the expansion is sudden, adiabatic conditions are approached so that the final temperature can be calculated. If the pressure used is such that the gas when expanded cools to a temperature at which the water vapour present begins to separate out as a fog or dew, then this temperature is the dew-point.

By means of a built-in hand pump, a sample of the gas is drawn into the instrument and held in the observation chamber above atmospheric pressure. The temperature of the gas is then read and the pressure quickly released by depressing the operating valve. This also switches the lamp on, illuminating the chamber, and if the gas has cooled to dew-point due to its rapid expansion, a fog will be observed through the window. Even where there are 'no dust' conditions the radium foil incorporated produces ions to act as substitute nuclei around which the droplets can form. The actual dew-point temperature is read from the slide-rule calculator which gives the relationship between initial temperature, pressure ratio and dew-point for the various Q values.

The instrument improves on others in this field by eliminating imprecise methods of reading and measurement, by making coolants unnecessary, and by enabling readings to be taken away from the source of the gas. It can be used, within its range, for any gas which is non-corrosive to brass or copper. It is claimed that the instrument has been so designed that it can be operated accurately by semi-skilled personnel. Sale and distribution is being carried out by—*Electric Resistance Furnace Co., Ltd., Netherby, Queens Road, Weybridge.*



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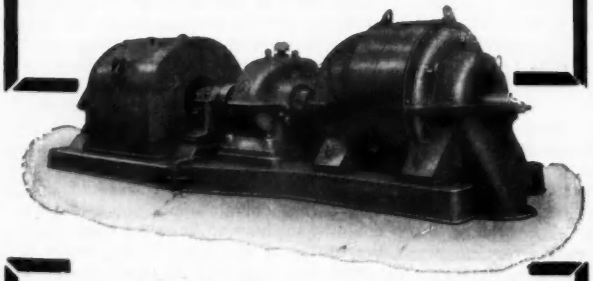

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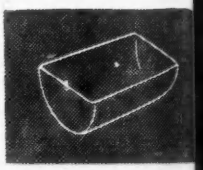

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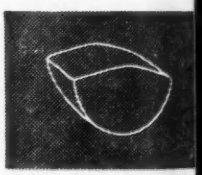

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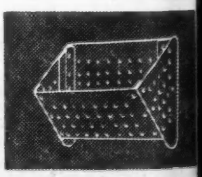

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